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Engineer for Maryland Commission

THERE is now before the Legislature of Maryland a bill providing for the appointment of an engineer on the Public Service Commission of that state. The Engineers' Club of Baltimore is using its influence in the passage of this measure and it was largely through its effort that such a bill was introduced. The bill proposes to amend the public service law by adding the clause "and one of said commission shall be an engineer." Engineers have long realized the desirability of having their profession represented on public service commissions, but until recently they have made no real effort to influence such appointments or to secure the passage of legislation requiring them. It is good news, therefore, that Baltimore's engineers have not been content with the plea that "something should be done," but are actually doing it. Their efforts deserve the solid support of all citizens of Maryland. In this connection it might be well for the Engineers' Club of Baltimore to impress upon the legislators of the state the fact that Governor Whitman of New York has recently named Henry W. Hodge, an engineer, as a member of the New York State Public Service Commission, which is in direct charge of the new subway work. This appointment received the hearty indorsement of the chairman of the commission, Oscar S. Straus, who, in an interview published in the Engineering Record of Jan. 29, page 159, summed up in convincing manner the desirability of having a technically trained man a member of a commission such as the one which operates in New York. It would seem that the Engineers' Club might make effective use of the Straus interview in influencing public opinion, for it comes from a man of broad vision and international prominence. If the Maryland Legislature has the interests of the state at heart it will enact into law the amendment suggested by the Baltimore engineers.

Refinements in Highway Construction

THE relation between inspector and contractor in construction work of any sort is an important factor in determining the quality of the finished product, but it has remained for California highway engineers to say that co-operation between inspector and contractor in concrete paving is necessary and sufficient to secure a certain continuity of grade which is noticeable to the motorist, but is hardly to be detected by ordinary inspection methods applied during construction. After all, the proof of the pudding is in the eating, and if certain conditions imposed during construction, such as those outlined on page 216 of the Feb. 12

Editorial Announcement

REALIZING the intense interest of the profession in the engineer's part in military preparedness, the Engineering Record will publish next week the first of a series of illustrated articles on

National Defense—For Engineer and Contractor

By MAJOR P. S. BOND
Corps of Engineers, U. S. Army

MAJOR BOND'S articles have the official sanction of the Secretary of War.

THIS series, continued through a number of issues, will be the most complete treatment of the subject in the annals of American technical journalism. It will give to engineer and contractor a detailed survey, by an Army authority, of the military engineer's training and manifold duties. A few of the topics discussed are:

Bridges and Stream Crossings; Plant and Tools; Map-Making and Reconnaissance; Roads; Demolitions; Sanitation; Field Fortification; and Mobilization of Industrial Resources.

issue, can bring about marked improvement in the finished product, then such conditions should become a part of the specifications in first-class construction. The checking of header board grades for concrete pavement is recognized as part of the inspector's duty, but ordinarily he gives the matter no thought beyond seeing that the grade is right. An example of what can be done by co-operation on this point between inspector and contractor has been demonstrated on certain road work in California. Where such co-operation exists successive sections of the pavement can be brought to a grade alignment so smooth that in riding over the finished surface the motorist at once notices its superior quality. The perfect continuity of grade is indicated by the entire absence of vibration, even in a machine traveling at high speed. The refinements in checking used on the work described are not at all unreasonable to require on any concrete highway work if the right spirit exists between inspector and contractor. Speaking generally it may be said that the good results of such a spirit of co-operation may not always be traced to their real cause, any more than the bad effects of antagonism can always be ana-

lyzed, but certain it is that friendly relations of the right sort never interfere and often help mightily in securing desired results. It is to the interest of both engineer and contractor to study carefully this phase of his work.

Newark's City-Planning Pioneers

SPACE was not available last week to comment editorially on the admirable report recently filed by the City Plan Commission of Newark, N. J., some of whose recommendations were set forth briefly on page 245 of last week's issue. The commission, after three and a half years of study, has presented what it modestly designates a tentative plan which, it thinks, should be discussed, revised and then adopted by a referendum. The plan, however, is perhaps the most comprehensive ever put forth in this country, and the highest praise is due these pioneers in a line of endeavor that is only beginning to come into its own. The Engineering Record does not wish to belittle in any way the admirable work being done by another group of pioneers in Philadelphia, whose work in the undeveloped South Philadelphia tract will be described in an early issue. Execution of the Newark city plan will require thorough intensive study such as is being done at Philadelphia; but in Newark the broad general study had to come first, if the plan was to include, as it does, the rectification of mistakes of long standing in the heart of the city, as well as the avoidance of such mistakes in the laying out of the undeveloped sections—and if it was to embrace the surrounding communities, as it does. As evidence of the broad-gage way in which the problem has been attacked, note the "non-financial undertakings" proposed for the first of the eight five-year periods: Revision of plan and submission to referendum, establishment of building lines on various streets, establishment of trolley service on various streets, re-routing of cars, creation of parks and a recreation department, making of districting study, changes in building codes and in tenement-house law, obtaining of new city-planning law, assisting of city planning in neighboring municipalities. Certainly the commission has gone whole-heartedly into its task, and Newark is to be congratulated for the example it has set.

Croton Watershed Menace

THE Merchants' Association of New York City is renewing its fight to prevent the use of the Croton watershed, from which the bulk of the city's supply is attained, as a site for state institutions housing from 5000 to 8000 people, mainly defectives. The opposition is based upon the menace to pub-

lic health involved in the sewage discharges from these buildings. The association has been instrumental in introducing into the State Legislature bills which, if enacted, would insure the protection of the water supply from such dangers as now seem imminent, and in calling upon its members to protest against the construction of the institutional buildings. With this movement the Engineering Record is in hearty accord. Its views on the subject have been expressed in former editorials and are reinforced by the opinions of sanitary engineers. It all gets down to the matter of whether or not a sewage treatment plant will be operated so as to produce a safe effluent *continuously*. When appointing officials recognize the urgent need of placing qualified sanitary engineers, chemists and bacteriologists in charge of the operation of sewage works this result—a satisfactory effluent at all times—may be within the realm of achievement. As many plants are now operated it is still a long way off. It is certainly anything but reassuring to those who would have the Croton water uncontaminated to know that the State officials who planned the buildings now under arraignment are the same ones who provided for sewage treatment, in recent contracts on other work of a similar character, by the electrolytic method, a process which, to say the least, has by no means established its claim to recognition as an efficient means of treatment.

Improvement in Patent Procedure

PROMISE of future improvement in the thoroughness with which the U. S. Patent Office will investigate patents is offered by the bill for a reorganization of the working force signed by President Wilson on Feb. 15. Last week, in the editorial on the Bone patent, it was stated that the lawyer-controlled system of conducting patent litigation and the lax investigation before issuance often led to mistakes and injustice, particularly in patents relating to engineering construction. The probability of better investigation before issuance is therefore encouraging, in view of the present chaotic state of patent litigation in this country evidenced by the federal court decisions against the Bone patent for cantilever reinforced-concrete retaining walls, discussed last week on page 243, and upholding the Thacher patent for arch reinforcement, discussed on page 274 of this issue.

Engineers will certainly welcome a clearer and more consistent policy in the granting of patents affecting their work. The contemplated reorganization and improvement in the patent office force should involve clear definitions of the fundamental elements in a patentable idea, and, more important still, a new basis for decision on the matter of details and the possibility of making slight modifications in a fundamental idea and obtaining a new patent. Undoubtedly, the procedure in patent issuance in the past has often resulted in injustice to the original inventor, not only in errors through incomplete evidence on the subject of prior use, but through the granting of later patents for inventions differing from the orig-

inal only in details of a very minor nature.

It cannot be too strongly urged that competent engineers should be consulted before passing upon the original application for a patent relating to engineering construction. Furthermore, in all suits concerning the infringements of such patents, it should be perfectly evident from the history of the patent litigation above cited that the well-qualified experienced engineer is the only reliable witness.

The Catskill Aqueduct Association

EVIDENCES of a desire on the part of engineers for something more than a mere association of professional interests are cropping out with increased frequency. In the past, the personal side of this relationship has been very largely subordinated to the technical. The tendency now is to digress, somewhat, from the narrow path which formerly has been followed. It has just been announced that a permanent organization, known as the Catskill Aqueduct Association, has been formed to perpetuate the friendships formed during the construction of New York's additional water supply system, which is now practically completed.

The object of the association is to bring together once a year all those who have been, or who are, connected in any way with the Catskill aqueduct work. Thus the new organization will be, in effect, an alumni association with annual reunions of its members. Many of the Catskill graduates, whom these reunions will bring back into the fold for a brief interchange of greetings, are now performing important work elsewhere. Robert Ridgway, for many years at the head of the Northern Aqueduct Department, resigned to assume the huge responsibility of directing New York City's vast program of new subway construction. Col. Merritt H. Smith, at one time deputy to Chief Engineer J. Waldo Smith, is now chief engineer of the New York Department of Water Supply, Gas and Electricity, and he has with him, as his first lieutenant, W. W. Brush, a Catskill aqueduct alumnus. Carleton E. Davis, at one time in charge of the great Ashokan reservoir work, is now directing the destinies of Philadelphia's Bureau of Water, and L. White, who was identified with some of the most important tunneling work on the aqueduct, left the city service to become managing engineer for Smith, Hauser & MacIsaac, one of New York's big subway and underpinning contractors. Frank E. Winsor is capitalizing the experience he gained on the Kensico dam in planning a new waterworks system for Providence, R. I.; in fact, the new Providence organization is made up very largely of former Catskill aqueduct men. While most of the engineers leaving the Catskill project have entered upon work along similar lines, B. H. Waite became division engineer of the New York State highway department.

These are only a few of the Catskill alumni. Now that the work for the first installment of 250,000,000 gal. daily is practically finished, others will be leaving to take up new duties, and old ties must be broken. The Catskill Aqueduct Association, how-

ever, will perform a useful service in bringing these men together occasionally and allowing them to renew the friendship of former years.

The Concrete Road Conference a Remarkable Gathering

LAST week witnessed the gathering in Chicago of a conference the like of which does not exist in the engineering field. An ephemeral organization, in a way, it nevertheless brought together for the second time a record-breaking attendance of technical men and produced discussions on a single general subject which, for volume and quality, are unique in American technical affairs.

The National Conference on Concrete Road Building, if standards of other bodies are used as a basis for judgment, should be productive of very little good. It has no permanent organization. It is not richly endowed with funds. It does not meet at frequent intervals. Yet the fact remains that it produced material of exceptionally high value, secured the participation of the very best men in the special field of concrete road construction and rendered an incalculable service to the profession and to the public. There were 698 persons registered—from as far away as California and Nova Scotia—while the average attendance at the six sessions was 400.

Such a showing leads one naturally to seek the reason. First, without doubt, is the intrinsic merit of the product itself—the concrete road. A form of construction with less to recommend it to engineers and to public officials could not bring such a group of men together a second time, even though skillful promotion had forced a first conference. Then, too, the rapidity of progress in concrete road construction has developed improvements and difficulties which formed excellent topics for discussion—topics on which many men were seeking the advice and experiences of others. Furthermore, the program was well planned. The subject of concrete road construction was split up into seventeen subdivisions and each was made the subject of a committee report. In this way the detailed problems were thrown into relief and naturally elicited the intimate experiences of the practical men present. Finally, the management was most skillful—in the selection of members of the committees, in advertising the meeting, in securing the attendance and participation of men of the very highest rank, in the handling of the program and in arranging the many small details which make for the comfort of those in attendance.

AFTER attending the road conference one cannot help contrasting it with other engineering meetings. It can be said without fear of contradiction that no meetings or conventions in the civil engineering field are more valuable than last week's conference except those of the American Society for Testing Materials and the American Railway Engineering Association. The two latter organizations are, of course, broader in scope than the concrete road conference, and go far beyond its mission in that they

formulate and adopt specifications which the other gathering does not. Meetings, therefore, that are not really comparable are here compared; yet it is significant that no other gatherings than these can be cited to convey an adequate idea of the character of the Chicago conference. The meeting of the American Concrete Institute, held in Chicago at the same time, and in the same hotel, was pitiable by comparison. The American Road Congresses, with their small attendance at the technical meetings, their papers on a great diversity of subjects, and their total lack of committee work, cannot be mentioned in the same breath with the Chicago gathering. The American Society of Civil Engineers, leader in prestige, has never been noted for the usefulness of its meetings, and can take only a qualified pride in its thorough, but plodding and conservative, committee work.

The secret of the success of the Chicago meeting of concrete road builders, and of the conventions of the American Society for Testing Materials and the American Railway Engineering Association, is that they are founded on the idea of "service." They exist not for show, not for pleasure, not for the prestige they can acquire by gathering unto themselves a distinguished membership (though they want that, too) but to afford a means for engineers to work out problems that press for solution and are too big for the individual to handle alone. In other words, they have no other object than to serve their members by producing material usable in their every-day work.

There is possibility of "service," of course, in many directions, and not merely in producing technical data—but no prominent organization in the civil engineering field to-day has formulated that ideal of "service" except as it applies to the technical work mentioned. Further and much desired progress of other organizations is not to be expected until there is a keen appreciation by the managements that the crying demand to-day is for service—service without loss of prestige. That appreciation would quickly result in the formulation of policies which would remove the criticisms now so commonly heard.

ONE other comment prompted by the committee work of the concrete road conference and of the testing materials and railway engineering organizations is apropos, because of the discussion of committee work at the annual meeting of the American Society of Civil Engineers. The support which bodies doing strong committee work are receiving is clear evidence that such work is meeting a demand and that engineers are quick to recognize organizations which can thus serve them. There is need for more, far more, committee work than is now being done, but that committee work must be vigorous and effective. A committee which lags, year after year disappointing the central organization, should be discontinued or given a new membership. No other course can save the committee and the society—and the reference here, of course, is general—from well-merited criticism.

The conference should not be dismissed

without brief reference to its financing. The funds were provided by the Cement Products Exhibition Company, formed of manufacturers, chiefly of cement. Yet nowhere was there evidence of the manufacturer save in open discussion and when the affiliation of the speaker was well understood. In fact, the tendency of the committees and of the speakers in the general sessions was to subject manufactured products to an especially strong scrutiny. Were the attitude of the manufacturers other than that taken—of hands off, so that the engineers could decide themselves—there would not have been participation a second time by the deans and professors of engineering of the very first rank. The presence of these distinguished gentlemen was a striking evidence of their confidence in the manufacturers who bore the financial burden.

American Specifications and Foreign Trade

THE executive committee of the American Society for Testing Materials has just made an announcement of unusual interest, not only to its own members, but to American industrial circles at large, in calling attention to an arrangement by which the Department of Commerce has undertaken the translation into foreign languages of such of the standard specifications of that society as have an important bearing on the requirements of American export trade. As explained in the news section of the Engineering Record last week, each specification in a foreign language will be accompanied by the original version in English as a criterion, and all numeric quantities will be expressed in both the British and the metric systems. It is intended to distribute these specifications among the United States consular offices throughout the world, and to make them available at moderate prices to American manufacturers and others interested in commerce with foreign nations.

The Department of Commerce and the American Society for Testing Materials are to be congratulated on the extraordinary opportunity that has thus been opened for rendering a service of momentous importance in the field of industrial preparedness. Industrial preparedness for prospective conditions of peace is second in importance only to such preparedness for the direful possibility of war. When the present European conflict comes to an end, there will surely follow immediately a fierce struggle for industrial and commercial rehabilitation on the part of the exhausted European nations. It is well known that the present commercial prosperity of this country had its origin in the pressing needs of the belligerent nations for the implements of warfare. Its ephemeral growth will be arrested, on the restoration of peace, just as suddenly as it sprang into existence shortly after the declaration of hostilities.

The question of vital moment to this nation, second only to that of military preparedness, is that of its preparedness for commanding its proper sphere in the prospective contest for the future control of world markets—a contest in which this nation has, in the past, fallen far short of

realizing its rightful possibilities. There can be no more opportune time than the present for this country to enter upon wisely and broadly conceived policies by which its present and future commercial relations with foreign nations, especially those on the American continent, may be placed upon a sound and enduring foundation. The recent Pan-American Scientific Congress has served in no unimportant measure to pave the way toward a better mutual understanding with our Central and South American brethren, and a clearer recognition of the solidarity of our interests. The American International Corporation, capitalized at \$50,000,000, and under the guidance of some of the ablest engineers, financiers, and men of large affairs, may be looked to with confidence, among other agencies, to shape and give practical effect to broad measures for the expansion and strengthening of the outer commercial relations of this country. Logically, the United States should become the chief purveyor of a long line of manufactured articles for which the Latin-American countries have to depend almost wholly on the outer world, such as structural steel, rails, bridges, locomotives and other rolling stock, automobiles, electric equipment, machinery and machine tools, cement and innumerable other products. Commerce in such products is, however, necessarily predicated on specifications.

American manufacturers have long labored under an unfair and unnecessary handicap in international competition by being required to base their prices for such articles on specifications of exotic, and usually European, origin, which are not infrequently framed designedly to meet the peculiar manufacturing requirements of a given country, to the embarrassment and disadvantage of American producers. It is high time that an end should be made of this unfair handicap, and that American manufacturers should be permitted to bid on specifications best suited to American conditions, and acceptable to the largest consumers in their own country. That international competition should be thus broadened would be obviously also to the direct advantage of foreign purchasers.

The importance of standard specifications in relation to international trade has long received recognition in Great Britain to a degree hitherto unknown in this country. The British Engineering Standards Committee, whose position in Great Britain relative to specifications is analogous to that of the American Society for Testing Materials in this country, has had, from its inception, the direct co-operative and financial support of the leading British engineering societies, in addition to substantial financial aid from the government. Although the American society has enjoyed neither of these advantages, its accomplishments in the field of standardization will bear favorable comparison with those of the British committee. It is peculiarly gratifying, therefore, that, through the enlightened co-operation of the Department of Commerce, the fruits of the admirable work of that society are about to be given added value in directions so promising to American commercial interests.



THE TUNNEL TIMBERS CONSTITUTE THE OUTER FORMS FOR THE CONCRETE LINING OF TWIN PEAKS TUNNEL

Wall-Plate Drift Method Used for the Most Part in Twin Peaks Tunnel, San Francisco

Double-Track Tube 12,000 Feet Long Being Built by Graduated Assessment Plan—Tunnel Lining Being Placed in Four Sections, with Special Two-Hinged Collapsible Steel Forms

THE WALL-PLATE drift method, with certain adaptations, is being used for the most part in advancing the headings of the 12,000-ft. Twin Peaks tunnel in San Francisco. Although the bulk of the concrete lining will be placed pneumatically, a concrete mixer and dump cars are being used for 1800 ft., and here a specially designed two-hinged collapsible form plays a part. The improvement is being paid for by a graduated assessment plan.

The tunnel, which the city is constructing under the contract system, will afford a much needed rapid-transit connection between the business district of the city and a desirable residence section which has not developed heretofore because of its inaccessibility. The tunnel will be ready for service in about two years, when a branch of the municipal railway will be operated through it. Funds to the amount of \$4,000,000 for the acquisition of the necessary lands and the construction of the tunnel were raised by means of a graduated assessment plan. Of the total amount, 85 per cent was raised by ten annual assessments from the undeveloped land near the southwest portal, which will be brought within eight minutes of the settled section of the city; while the remaining 15 per cent was assessed on the property on that part of Market Street adjacent to the northeast end of the tunnel.

MATERIALS ENCOUNTERED.

The standard tunnel section for soft material measures 30½ ft. in width on the outside of the concrete lining, and 28 ft. in height from bottom of invert to top of arch. In some of the station sections the inside width increases to as much as 44 ft. to allow for platforms on either side of the tracks, and in this case the over-all width of the concrete section is as much as 62 ft.

The tunnel section varies somewhat according to material encountered, the thickness of the lining being less, of course, in the rock sections, but a minimum clearance width of 25 ft. is maintained, and the standard height throughout from rail head to ceiling slab is 15 ft. This ceiling slab cuts off a segmental space 4 ft. 6 in. high in the center and just below the arch of the tunnel, which will be used as a ventilating duct.

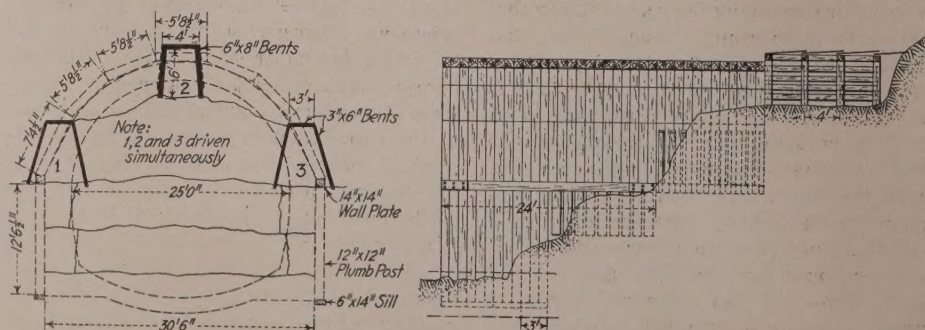
In the preparation of designs and the compilation of the preliminary report by the city engineer a large number of test holes were sunk along the center line of the tunnel. These showed a predominance of sandy clay with occasional sand, about 5000 ft. of rock beneath the highest part of the hill, and at a few points some broken and disintegrated rock. In the 1800 ft. which have already been completed at the west portal the material has been clean sand and sandy clay, which has been fairly easy to work and to hold in place. At the west portal sand and hard clay have been encountered as far as the heading has been advanced, while at the Laguna Honda station, where the tunnel was built in open cut for some distance, the same favorable soil conditions prevail.

After going over the tunnel line carefully some of the experienced tunnel men on the work find indications of water-bearing sand between the Laguna Honda station and the eastern portal that may prove difficult to handle.

On Jan. 1 90 per cent of the excavation at Laguna Honda station was completed and 70 per cent of the concrete was in place. Excavation in open cut has been finished at both portals and at Laguna Honda station, a total of about 195,000 cu. yd. having been taken out by open-cut methods. At the east end of the tunnel the work has been finished for a distance of about 2000 ft. from the portal, including the Eureka Valley station, 300 ft. in length.

WALL-PLATE DRIFT METHOD

As previously stated, the wall-plate drift method has been used for the most part in advancing the headings, certain adaptations being made to suit the conditions met at various points. The two wall-plate drifts were driven with incline posts practically paralleling the lower segments of the arch so that a minimum of space would be left



METHOD OF DRIFTING AND TIMBERING—WALL-PLATE AND CROWN DRIFTS DRIVEN SIMULTANEOUSLY

tract 1000 calendar days were allowed for the completion of the work. The construction is under the supervision of M. M. O'Shaughnessy, city engineer of San Francisco, for whom L. T. McAfee is resident engineer in charge of construction.

Patent for Arch Reinforcement Declared Valid

Short Historical Sketch of the Patent Situation—Reasoning of Lower Court Upon Which Court of Appeals Acted Favorably

THE RECENT affirmation of the decree of the Maryland District Court by the U. S. Circuit Court of Appeals for the fourth circuit in the case of Edwin Thacher against the city of Baltimore, practically fixes the validity of the Thacher patent. In view of the importance of this decision and its direct influence in the broad field of reinforced-concrete arch bridge design, there is given here a short history of this patent, its essential principles and an abstract of the reasoning of Judge Rose in the Maryland District Court which was affirmed by the Court of Appeals, as noted in last week's issue, page 263.

ESSENTIALS OF PATENT

In the specification forming part of the patent No. 617,615, dated Jan. 10, 1899, issued to Edwin Thacher, it is stated that the invention relates to concrete arches for bridges or vault covering, or for spanning openings in building construction. It has for its object an improved arch structure in which iron or steel bars are imbedded in concrete near the outer and inner surfaces of the arch in such a manner as to assist the concrete in resisting the thrusts and bending moments to which the arch is subjected.

The invention provides, first, for an effective connection between the bars and the concrete, employing lugs, dowels, bolts, or rivets; second, for bars of such form that they can be readily and cheaply spliced if a greater length of bar is required than that which can be conveniently rolled or shipped; third, for bars that can be manufactured at a small cost and as a standard or stock article and can be readily bent when used to the curve of the arch into which they are to enter. Ordinarily, the bars are in pairs, one vertically above the other, although it is not considered that this manner of disposing the bars is essential in all cases.

The bars act as the flanges of beams to resist bending moments, whereas the shearing stresses, which are small, are taken by the concrete alone. Normally, the bars and concrete act together, but if the concrete is defective and has a tendency to crack, the bars will greatly aid in resisting such tendency and if a crack should take place the relation of the parts will be changed, and the bars will do the work of the concrete and prevent the falling of the structure.

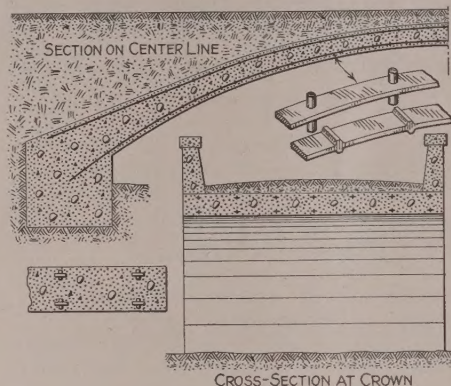
PRINCIPAL CLAIMS

Three separate claims are made in the patent. The first claim is as follows: "The combination with abutments, and the concrete arch spanning the intervening space, of a series of metal bars, in pairs, one bar of each pair above the other, near the intrados and extrados of the arch and extending well into the abutment, each bar of a pair being independent of the other"—substantially as

shown in the drawing. The second claim is similar except that one bar of each pair is to be placed vertically above the other, and each bar is to be flat and provided with projections. The third claim is the same as the first except that one bar of each pair extends into the abutment.

HISTORICAL RECORD

This patent was applied for Oct. 16, 1896. Its history in the patent office shows a very thorough search on the part of the examiner, extending over a period of more than two years, during which time 18 United States and foreign patents were referred to. Of the 17 patents, only one had any bearing on these claims, and sworn testimony was produced showing conclusively that a bridge was under construction on the Thacher system before this one was applied for. The exact date of the Thacher invention is unknown, but it was some time early in 1895. An estimate for a small



PART OF ORIGINAL SKETCH ACCOMPANYING PATENT SHOWS ESSENTIAL FEATURES

bridge was made July 6, 1895, and the first bridge completed under this system was in August, 1896.

The earliest record of concrete reinforced with metal is some experiments made by Malet in France in 1845. At the World's Exposition in Paris in 1855, he exhibited a reinforced-concrete ship. The idea was to replace wood in ships by reinforced-concrete plates, but this never came into practical use. Joseph Monier of France is generally given the credit of being the original inventor of reinforced concrete. The main idea in the Monier invention, shown in his basic patent of 1867 and in all of his subsequent patents, is a flexible net work of wires, wired together at all intersections. The Monier patent was first used for tree pots, using imbedded wire nets; next for water and gas tanks; next for tubes and sewers; next for vaults and bridges, and finally for flat floors. The genuine Monier system had only one wire netting at the intrados of the arch, and no sample has been found of two complete wire nettings used in the Monier bridges.

THREE EARLY SYSTEMS

In 1896, only three systems of concrete-steel arches were in use, the Melan system, the Wunsch system, and the Monier system. The Melan system consists of beams imbedded in concrete at regular intervals, usually from 2 to 3 ft. apart. The beams at first used and shown in the patent were I-beams of uniform depth, usually the depth of the arch; later, and first used by Mr. Thacher, rolled I-beams were replaced by riveted beams, composed of two angles near the intrados and two angles

near the extrados, the four angles being rigidly connected by tie plates and diagonal lacing bars, which transmit stresses from one flange to the other. It is clear that the Melan system has no similarity to the Thacher system.

The Wunsch system is used only for shallow arches horizontal on top to form the floor of the bridge, and curved at the bottom only. All Monier bridges have been built with mortar composed of one part cement and three parts sand, as the fineness of the netting prevented the use of concrete.

JUDGE ROSE'S OPINION

In deciding the suit brought by Mr. Thacher against the city of Baltimore for an infringement of the first and third claims of patent No. 617,615, Judge Rose, after reviewing the history given above, called attention to the advantages of the arrangement of bars in the patent, as explained by the plaintiff's expert, who showed that the metallic reinforcement is the more valuable the further it is away from the neutral axis of the arch and the nearer it is to the upper and lower surfaces thereof. In recognizing this principle and turning it into practical use, stated Judge Rose, the plaintiff did something which most of the patents cited against him did not.

There is one, No. 583,464, granted to Von Emperger on June 1, 1897, which embodied this idea. This patent was issued before that of the plaintiff upon an application which antedated his by five months. The patent office cited it against the plaintiff, who thereupon filed affidavits carrying back his invention to a period prior to the date of Von Emperger's application. Under the patent office rules the patent was then issued to the plaintiff.

It is quite possible to argue that there were so many forms of reinforced-concrete arch construction before the plaintiff devised his, that no invention was required to do what he did. On the other hand, the grant of the patent raises a presumption of invention. In this case, the presumption is supported by evidence that the invention went largely into use and that until 1910 there was no serious attempt to infringe upon the exclusive rights of the patentee.

There is testimony that others paid handsome royalties for licenses to build their bridges in the manner shown in the patents in suit. There was absolutely no testimony to the contrary, although the city examined an expert witness of large experience in concrete arch construction, as well as the very eminent chief engineer of its sewerage system. The latter frankly admitted that he could not recollect having seen or heard of any bridge or arch constructed in accordance with the plaintiff's designed before the issue of the patent in suit.

In conclusion Judge Rose said:

"Under the circumstances I am not prepared to hold that the claims in suit are void, either because of direct anticipation or because, in view of the state of the prior art, they do not disclose the invention.

CITY'S CONTENTIONS INVALID

"The city points out three respects in which its structure, the Fallsview viaduct, is unlike that shown in the patent. These are, that upon its arches rests no spandrel filling, that the upper of each pair of its bars is not in precisely the same vertical plane as the lower, and that its construc-

tion consists of a series of arches one end of each of which in all cases, and both ends in most, are supported by piers rather than by abutments. Of these differences in their order:

"There is not a word about spandrel filling in the patent claims, although one drawing indicates such filling. It is utterly immaterial for any purpose connected with the construction in suit whether there shall be any or not. The patent would be infringed the moment the arch was constructed although neither spandrel filling nor any other covering was ever placed upon it.

"That in the city's arches the upper bar of each pair is not vertically directly over the lower is true. In some cases it is $1\frac{1}{2}$ in. out of the vertical line. The city's engi-

neers says that there was no purpose in so arranging the bars. It was a mere accident in the design of construction. It is not suggested that such a slight departure from the form shown in the patent makes any real difference.

"It is perfectly obvious that the word abutments as used by the patentee was intended to include both abutments and piers. If the structure only calls for one span there will be only one arch supported by two abutments. If there be more than one arch the ends of some of them will be supported by piers.

"No question has been raised but that an arch is a manufacture within the meaning of the patent law. The plaintiff is therefore entitled to a decree for an injunction and an accounting."

Concrete Road Conference Adopts Code of Recommended Practice

Covers Briefly Main Features in Every Branch of the Work, from Drainage and Grading to Finishing and Curing

IN the final session the Second National Conference on Concrete Road Building, meeting in Chicago last week, adopted a code of practice recommended for the construction of concrete roads and pavements. Each division of the work is taken up, and the views as to best practice, as presented in committee reports and developed in the discussion, are set forth briefly; as is natural most of the code is devoted to aggregates, methods of mixing and placing, and such other details as are most likely to affect for better or worse the concrete pavement. Controversial matters are avoided.

The code adopted is as follows:

1—SPECIFICATIONS

Since no specifications were considered by the Conference the Standard Specifications for Pavements and Roadways of the American Concrete Institute are recommended.

2—DRAINAGE

The drainage of the roadbed is of vital importance. If the subgrade is not well drained, there is danger of unequal settlement or frost action, which will cause cracks. The method of drainage to be used will depend on local conditions. For roads proper drainage may be secured through lateral ditches. For streets, as well as roads, tile drains may be used which should be laid on each side of the roadway, or on one side only, with cross drains leading thereto at a suitable depth, depending on the width of the pavement. Drainage trenches, if placed under the subgrade, should be completed before final rolling.

3—GRADING

When roadways are constructed over fills extreme care should be observed to insure the use of proper materials in layers of such thickness that they may be thoroughly compacted so that when the fill is completed there will be a minimum of settlement. In general, fills shall be made in thin layers, the depth depending on the character of material to be used in making the fill. The fill should be allowed to stand for as long a time as possible, giving it an opportunity to settle thoroughly before the pavement is

placed thereon. Deep fills should be allowed to settle through one winter wherever such procedure is possible. Puddling will be found advantageous in compacting deep fills. Wetting and rolling shall be performed when making a fill in order to secure thorough compactness. Fills should never be made with frozen materials nor with lumps greater than 6 in. in their greatest dimension.

4—SUBGRADE

The fundamental requirement of the subgrade is that it should be of uniform density so that it will not settle unevenly and cause cracks in the surface of the pavement. No part of the work is more worthy of intelligent care and painstaking labor than the preparation of the subgrade. The slight additional cost necessary to insure good results is abundantly justifiable. When the pavement is constructed on virgin soil, care should be taken to remove all soft spots so as to insure a uniform density; and if constructed on an old roadbed, even greater care must be taken to secure uniform density, as the subgrade is likely to be more compact in the center than at the sides. An old roadbed should be scarified, reshaped and rolled. The subgrade adjacent to curbs should be hand tamped.

5—MATERIALS

Portland Cement—Portland cement shall meet the requirements of the standard specifications for Portland cement of the American Society for Testing Materials and tests should be made in accordance with the methods of tests outlined by the American Society of Civil Engineers.

Aggregates—The selection of proper aggregates for concrete road construction is of utmost importance. Clean, hard, well-graded materials are absolutely essential to success. For this reason samples of the materials proposed for use should be submitted to the engineer for approval before orders are placed. These samples should be carefully inspected; and, if possible, laboratory tests made to determine their suitability. If laboratory tests on shipments cannot be made, field tests can be used to furnish a general indication of quality.

The different aggregates should be kept clean and separate.

Aggregates to be used in the wearing course of two-course pavements should never be placed on the subgrade but on planks or some other means provided to keep them free from dirt. When aggregates are placed directly on the subgrade care should be used by the shovelers to avoid getting clay or earth shoveled from the subgrade into the mix. Aggregates should not only be clean when they are delivered on the job, but clean when placed in the mixer.

Water—Water supply is a most important factor and is frequently overlooked by the engineer and contractor. A large supply of water is necessary for (a) sprinkling the subgrade; (b) mixing the concrete; and (c) keeping the concrete moist during early stages of hardening. For this latter purpose 25 to 30 gal. per square yard of pavement will be required during the summer months. Insufficient sprinkling is detrimental to the wearing qualities of the pavement.

Reinforcement—The use of reinforcement in concrete pavements is increasing.

A coating of light rust will not be detrimental to satisfactory results but care should be exercised that no excessive rust, paint or other coatings are present to interfere with proper bond. Care should also be exercised to see that the reinforcement is so stored, prior to use, that it is not covered with mud or clay when placed in the pavement. Reinforcement left on a job when contract is not completed at the end of the season should be collected and stored so that it is protected from the elements. Occasional tensile and bending tests should be made to see that the requirements of the specifications are fulfilled.

Joint Filler—Joint filler should preferably be of a single thickness. Transverse joint filler should be cut to the crown of the pavement by the manufacturer when metal plates are used. A type of joint filler which will iron out readily under traffic is preferable for use in unprotected joints. A joint filler which will not bend easily when concrete is deposited against it is to be preferred.

Joint-Protection Plates—Metal joint-protection plates should be properly bundled and wired by the manufacturer so that they will arrive on the work in good condition, free from warp. Protection plates up to 20 ft. shall be shipped in single lengths. The exact length should be provided so that the contractor will not find it necessary to cut plates. In cutting plates for length, spacing between eccentrics on the installation bar should be considered to avoid interference with anchorage lugs on plates. Particular care should be used by the manufacturer in crowning the installing bar, to avoid the necessity of duplication of work by the contractor.

6—FORMS

Metal forms of sufficient strength to withstand the necessary hard usage are preferred. When wooden forms are used they should be of at least 2-in. stock and capped with a 2-in. angle iron, so constructed that adjacent sections can be lapped. Forms should have a width not less than the thickness of the pavement at the sides. Particular care should be exercised to see that the top edge of forms are clean so as to avoid unevenness in the finished pavement. If forms are warped or stakes not properly

placed, a poor alignment of the edge of the concrete slab will result.

7—PAVEMENT SECTION

Thickness—The thickness of a concrete road or pavement is controlled by many factors, each of which should be given consideration. In view of the increasing use of the heavy motor truck and bus, it seems unwise to build pavements with a thickness of less than 6 in. at any point. In general, pavements shall be thicker at the center than at the sides. Alleys with an inverted crown and narrow one-slope roads should have a uniform thickness. Wherever the thickness can be increased without excessive cost, to secure a flat or nearly flat subgrade, such increase is advisable.

Width—The desirable width for single-track road is 10 ft. The desirable width of double-track roads is 18 ft. The total width of the roadway should not be less than 20 ft. for single-track roads and not less than 26 ft. for double-track roads.

Crown—The crown of roads and pavements should be not less than one one-hundredth nor more than one-fiftieth of the total width. Except in unusual cases, one one-hundredth will be sufficient for country roads and one-fiftieth will be considered satisfactory for alley pavements. For city streets an average crown of one-seventy-fifth will generally be found sufficient and should not be reduced, except on grades.

8—JOINTS

Transverse Joints—Joints should be placed across the pavement perpendicular to the center line about 50 ft. apart.

There seems to be a tendency to widen the distance between joints.

Joints should extend entirely through the pavement as well as through the curb if integral curbs are used. Joints should be constructed perpendicular to the surface of the pavement to avoid the possibility of one slab rising above the other.

Longitudinal Joints—Longitudinal joint filler should be staked or otherwise securely held against the curb. Joint material should also be placed around manholes, catch-basins, etc.

Protected Joints—The tendency of present practice is toward the omission of metal protection plates for joints. It is possible that the value of metal protection plates is dependable somewhat on the character of aggregate used, and it is considered that they are more essential in street pavements than in country highways.

Plates—Plates for protected joints should be wired together with the joint filler in place and securely held in the installing bars. When short sections of joint filler are used they should likewise be wired together. Supports for the joint should be used when the pavement is of such width that the installing bar deflects. On wide streets every joint should be checked as to crown with sighting T's. When necessary to have joint plates in two sections, the contractor should arrange with the manufacturer to have holes drilled in the abutting ends of the plates so that the plates may be securely wired or strapped together. As the joint plates usually do not fit tight to the installing bar, a 1/4-in. shim is placed under each end of the installing bar, to insure that the plates are not covered by the concrete.

9—MIXING AND PLACING CONCRETE

Measuring—The method of measuring materials for the concrete, including water, should be one which will insure accurate proportions of each of the ingredients at all times. It is recommended that a sack of Portland cement, containing 94 lb. net, be considered the equivalent to 1 cu. ft.

Proportioning—The proportions should not exceed five parts of fine and coarse aggregate measured separately to one part of Portland cement, and the fine aggregate should not exceed 40 per cent of the mixture of fine and coarse aggregates.

Aggregates—Bank run material should not be used. Proportioning based on sieve analysis or by relative density tests is not practicable for concrete roads, except where laboratory direction is available; but where proper facilities are available the above proportions should be varied as the tests warrant.

Mixing—The ingredients should be mixed in a batch mixer of approved style, and the size of the batch should not exceed the rated capacity of the mixer. The mixing should be continued for at least 1 min. after all the materials are in the mixer and before any of the concrete is discharged. The speed of the mixer should not exceed 16 revolutions per minute; however the time and not number of revolutions should be the gage of proper mixing.

Consistency—The practice is to mix concrete entirely too wet. The consistency should be such as not to require tamping, but not so wet as to cause the separation of the mortar from the aggregate in handling and placing. The strength and wearing qualities of the concrete are vitally lessened by an excess of water in mixing.

Placing—If the subgrade has been disturbed by teaming or other causes, it should be brought to its former surface, and thoroughly saturated with water. The concrete should be deposited rapidly to the required depth and width. The section should be completed to a transverse joint, without the use of intermediate forms or bulkheads, or a transverse joint may be placed at the point of stopping of the work. In case the mixer breaks down the concrete should be mixed by hand to complete the section. Where reinforcement is used it should be embedded in the concrete before the concrete has begun to set; the concrete above the reinforcement should be placed within 20 min. after the placing of the concrete below.

In two-course pavements the top should be placed within 20 min. after the placing of the bottom.

Finishing—The surface of the concrete should be struck off by means of a template moved with a combined longitudinal and transverse motion. The excess material accumulated in front of the template should be uniformly distributed over the surface of the pavement except near the transverse joint, where the excess material should be removed.

The concrete adjoining the transverse joint should be dense and any depressions in the surface should be filled with concrete of the same composition as the body of the work. After being brought to the established grade with a template, the concrete should be finished, from a suitable bridge, with a wood float to true surface. A metal float should not be used.

Brooming of the surface is not necessary and grooves are objectionable even on grades.

10—RETEMPERING

Retempering of mortar or concrete which has partially hardened, that is, mixing with additional materials or water, is strongly condemned and should not be permitted.

11—PROTECTION AND CURING

Even the best concrete may be seriously damaged by too rapid drying out, early exposure to low temperature, or by being opened to traffic at too early a period. Hot sun and drying winds are most liable to dry out the concrete too rapidly, thus causing shrinkage cracks or causing a surface which will not wear well under traffic. The use of a canvas covering will be found effective in overcoming this condition.

Sprinkling should also be employed as soon as the concrete is hard enough to prevent the surface being pitted. An earth covering or protection by ponding should be employed after the first day. Under most favorable conditions such protection should be given the pavement for at least two weeks. Water should be added during this period to keep the concrete wet.

In cool weather it is often advisable to omit the earth covering, thus allowing the concrete to harden more rapidly. Sprinkling should not be omitted during the day in case the surface shows a tendency to dry out. When there is danger of frost, sprinkling should be omitted and a covering of canvas or straw and canvas used.

Placing concrete in roads and pavements in temperatures at or near freezing is not advisable, and if in special cases, such work is unavoidable, the water and aggregate should be heated and precautions taken to protect the concrete from freezing for at least 10 days. Chemicals to lower the freezing temperature of the mixture should not be used.

Concrete should not be deposited on a frozen subgrade.

12—OPENING TO TRAFFIC

Under most favorable conditions a concrete pavement should not be opened to traffic in less than two weeks and when conditions permit this interval should be at least four weeks.

13—ONE-COURSE PAVEMENT

Where the materials most readily available are such as to give good construction in one-course pavement, this convention recommends that the one course be used.

14—INTEGRAL CURB

The integral curb for concrete street pavements is recommended in preference to straight curb or combined curb and gutter. Such construction eliminates the longitudinal joint along curb, maintains a permanent grade and alignment. Precaution should be taken to insure that the curb is thoroughly bonded to the pavement proper. The integral curb can be used on wide as well as narrow streets.

FOUR CONCRETE PONTOONS for landings for small boats at Balboa are being built on the floor of the new drydock at that point, states the *Canal Record*. They will support gangways at the heads of the slips alongside pier 18. Each will be 120 ft. long, 28 ft. wide and 8 ft. deep, and as the pontoons are designed to support heavy weights and withstand severe knocking, the system of reinforcement is elaborate. The truss bridges gangways have been completed.

Present Practice in Concrete Design and Construction Summed Up at Convention Last Week

Abstracts of Some of the Papers Presented at the Twelfth Annual Meeting of the American Concrete Institute held in Chicago, February 14 to 17

Spiral vs. Vertical Steel in Concrete Columns

Column Tests Reported Last Year Are Cited in Claim That Most Building Ordinances Are Incorrect for Hooped Columns

By PIERCE P. FURBER

Resident Engineer for C. A. P. Turner, Chicago

REINFORCED-CONCRETE COLUMN tests reported last year to the Institute show by comparison that most of the building ordinances now in effect are far from correct in the specifications for unit stresses on hooped columns. (See the *Journal*, American Concrete Institute, February, 1915, page 47, or the abstract in the *Engineering Record* of April 24, 1915, page 527.) Being published nearly simultaneously with accounts of the Edison fire, this report brought the subject of concrete columns vividly to the attention of those in the building business, regarding questions of both safe loads and fire resistance.

It seems to the writer that there is no lesson in the Edison fire for the experienced engineer, for the reason that it could have been expected that such columns as those, without hooping of any kind, should have acted very badly in a hot fire. Supposedly, it is well known to structural engineers that columns vertically reinforced and hooped with sufficient spiral reinforcement of close pitch, are much to be preferred to columns with vertical rods only, even in case ties are used, although they were not in the Edison buildings.

In spite of this knowledge, columns without hooping are being built extensively throughout the country, although it is common practice to use ties or stays of small-diameter rods or wire for lateral reinforcement, spaced about 1 ft. apart. The reason for the use of this inferior construction is found in the lower cost of that type as compared to the hooped column when designed according to most building ordinances.

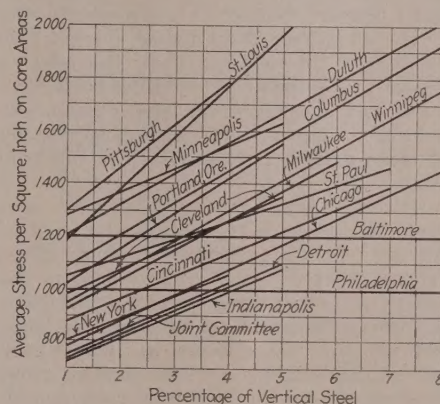
BAD BUILDING ORDINANCES

Many building ordinances place a premium on this dangerous construction by allowing higher relative stresses on the concrete of such columns than on spirally reinforced columns, when we consider the increase in ultimate strength of the latter. Some even permit as great unit pressure on the concrete of a column without hooping as on a well-designed hooped column. In other words, the concrete of tied columns is stressed beyond what should be permissible values, and the hooped column, instead of being given the benefit of its increased toughness and reliability, is actually put at a disadvantage, because the allowed stresses are lower than tests have shown to be safe.

The results of such building laws are obvious. Designers will use the cheaper type, except in some cases where it may be possible to control the design of the work with regard to actual strength secured in the structure rather than with a view to meet

the requirements of some building department. It may be said that a conscientious engineer will always work on this principle, but this is not so, and will hardly be possible where there is an ordinance limitation. The engineer has no opportunity to use his best judgment.

Most of the failures of concrete structures have occurred in buildings designed so that the figured unit stresses were not too high when judged by ordinance requirements, and the failures have been due to failures of the type of member rather than of the material. A large number can be blamed on the use of columns without hooping. On the other hand, the writer at least



ALLOWABLE UNIT STRESSES FOR HOOPED COLUMNS VARY WIDELY

Lines show values in the various building ordinances for 1 per cent hooping. Seattle is the same as Chicago. Toronto and Syracuse are the same as Detroit.

has never heard of the failure of a hooped column in a building. The continued service of hooped columns under pressures which, according to some building laws, would be considered dangerous leads one to believe that something is wrong with the building codes.

UNIT STRESSES FOR HOOPED COLUMNS

The writer believes that the tests have proved that most of the building ordinances are too conservative in the unit stresses permitted for hooped columns and a number of them too liberal in the allowances for columns without hoopings. Consequently, the cities represented in the accompanying diagram which appear to have radical ordinances are nearer to agreement with the test data than those at the other end of the scale. Some building departments have been progressive enough to recognize fully the advantage of hooped columns and have incorporated in their ordinances values in keeping with the strength disclosed by tests.

The tests of the American Concrete Institute have proved the contention that hooped columns are to be preferred and will be cheaper than rodded columns, if properly designed. The proof lies in the comparative strength exhibited by the tested col-

umns. It is to be regretted that the tests did not cover a wider range of spiral percentages, and also that the concrete mix was 1:1½:3 instead of the standard 1:2:4 mixture usually employed in building construction.

Need Accurate Estimates Based on Unit Costs

Contractors in Concrete Construction Can Reduce Costs by Thorough Analysis and Systematizing of Labor Operations

By SANFORD E. THOMPSON
Consulting Engineer, Boston

THE aim of this paper is to call attention to the necessity for more accurate estimates by architects, engineers and contractors, and to the possibility of reducing construction costs by a more thorough analysis and systematizing of the labor operations. Open any technical paper giving construction items and notice the enormous variation in bids received from contractors for the same job. At random, I find four bids in a current engineering periodical on a certain job, as follows: \$117,000, \$126,000, \$143,000 and \$171,000. This does not represent an exceptional case, but is the general rule on work in which the cost of labor is relatively large.

Unquestionably, the methods of management, especially on construction jobs, affect the cost to a very large extent, but it is hardly conceivable that differences of, say, 50 per cent in cost can be accounted for in this way. Assuming, as is generally the case, that the bidders really try for the job, there is evidently gross error in the estimating. The variations must be due to one of three causes: (1) inaccurate estimates of volume or cost of materials; (2) inaccurate estimates of labor costs, or (3) inaccurate estimates of overhead costs and profits. The items of overhead costs and profits are combined because they are practically interdependent. The contractor, for example, who handles a job personally has small overhead expenses but requires a larger profit to make up for the value of his own time than does a large contractor whose overhead costs in salaries and plant are large, but whose percentage in profit may be small and yet yield a large total income.

ESTIMATED LABOR COST ERRORS

Material costs usually are figured without trouble. The variation in overhead costs by two different estimators may be large, because many contractors do not properly charge or divide their overhead items, but this difference on any one job can hardly account for more than 10 per cent. The big variation, then, must be in the estimated labor cost. As a matter of fact, this is the item on which money is made or lost in contracting.

A contractor was asked recently why he did not bid on a certain reinforced-concrete

bridge. The reply was, "I have built mine." Construction companies handling reinforced concrete will tell you that a contractor does not begin to make money until he gets his third job, provided he stays in the game as long as this. The first job costs him more than his estimate; he bids low on the second job because he thinks he sees where he has lost money on the first, and on the third job he knows he has been a fool and adjusts his bid accordingly.

FOLLOW-UP SYSTEM REQUIRED

It must be the aim not simply to know how to do the work cheaply, but to figure estimates more accurately, and at the same time take care to keep the cost of estimating as low as possible. It is evident, further, that, having made the bid with care, the construction must be handled in such a way as to come within the limits set. This requires not simply a fair comparison with the monthly estimates, but the follow-up from day to day of quantities and wages, so as to have a running check on the work. It takes but little more time in figuring an estimate where material costs are estimated in detail also to obtain unit costs of labor.

In reinforced-concrete construction, the greatest discrepancy lies in the cost of forms. It is here that the contractor, and also the engineer, are apt to be fooled, unless either they are well provided with unit costs, or have handled work previously of an identical nature. [Mr. Thompson then cites examples showing danger in using previous costs on work of a different kind, and the uncertainty in the use of units, comparing the cubic yard with the square foot. He refers to tables in "Concrete Costs," by Taylor and Thompson.]

INACCURACY OF COST DATA

Much has been written of the inaccuracy of cost data, and with perfect truth. On the other hand, if the unit costs are taken from personal experience or from records in which all the local conditions are fully stated and the average values compiled, they are of immense value in estimating and in following up the work. Care must be taken, of course, to provide for indirect charges such as foremen, sharpening tools, miscellaneous work, and contingencies.

REDUCING CONSTRUCTION COSTS

Up to this point there has been considered the substitution of accurate methods for guess work in estimating. The more important question is how far the knowledge referred to can be utilized in reducing costs. Accurate cost keeping is of value in following up construction costs from day to day by showing waste labor and in providing a mark for attainment of superintendents and foremen. Unless cost knowledge is in the form of small units, such comparisons cannot be made satisfactorily.

To get the full benefit of a knowledge of unit costs it must be utilized in the planning of the work in advance, and in distributing materials and jobs; in selecting materials and methods which will result in lowest labor costs; in adapting the construction plant to the special conditions; and, carried to its ultimate end, in laying out jobs for the workmen and giving them a reward for accomplishment.

Such management involves the adoption of factory methods in construction. Already the need of this is being recognized, but only to a limited degree. The presi-

dent of one of our large construction companies states that on one job he made \$10,000 by the adoption of methods involving systematic planning and routing. Full economy in construction can only be attained as the builder discards the haphazard rule-of-thumb method and considers his job with a view to thorough analysis, planning functional methods, and a complete study of details. By such methods as these will the labor of construction be brought to a more scientific basis and more nearly on a par with the material end of the work.

Designing Concrete Form Work Reduces Costs

Contractors Should Design and Plan the Form Construction—Experiments on Equivalent Hydraulic Pressure Cited

By R. A. SHERWIN

With the Aberthaw Construction Company, Boston, Mass.

SOME of the points mentioned by H. S. Taft in the paper on "Strength of Concrete Forms," presented to the Institute last year, are worthy of further discussion, and I propose to describe the methods used by the Aberthaw Construction Company in handling form work, to show the relation between the important features of form work, and show how we have successfully reduced the cost of forms by a careful study of their design, buying material and field work.

Numerous cost analysis diagrams prepared in our office from the actual cost of average reinforced-concrete buildings of the industrial type, not taking into account the cost of any equipment, show that the labor on forms averages about one-third the labor cost, which is about 35 per cent of the total cost of the building, and the lumber about one-tenth of the total material cost, including subcontracts. The design and erection of forms is therefore the most important single item in concrete building construction, and one upon which much thought and study can be well spent.

CONTRACTOR SHOULD DESIGN FORMS

In the March, 1915, issue of *Concrete Cement Age*, Jerome Cochran in an article on forms, says "Plans and details for forms, if required to be furnished by the contractor, should be submitted to the engineer for his approval before starting the work, but such approval should not release the contractor from any responsibility." I do not believe that this is the correct position to take in this matter. The engineer should be interested in results only. The finished building must be as he specifies. Since he holds the contractor responsible for results, the methods of doing the work should be left to the contractor entirely. The engineer has his work in designing the structure. The contractor ought to know more about designing forms. It is his business to know how to build.

Economical forms must be designed as light and with as few pieces as possible to give the necessary strength and stiffness. Remember, on the one hand, that human lives and the cost of failure, in both money and reputation, are dependent upon the design, and, on the other hand, that form work is a temporary structure fully loaded for a short time only and a lower factor of safety is therefore allowable. The main question, then, is one of strength with enough stiff-

ness to prevent any appreciable sags in the finished concrete.

One place where deflection should be carefully guarded against is at the window head, where a slight deflection will cause much trouble and expense in setting the sash. The principal cause of settlement of form work is crushing of the soft spruce or pine lumber perpendicular to the grain in the girt over the post and also in the adjustment of the wedges under the posts as the full load is applied. An average safe value to use in form design for crushing across the grain, as determined by numerous tests, is 400 lb. per square inch for spruce. I believe that limiting the floor timbers to very small deflections and at the same time using high loads on the posts is not consistent, and surely not economical.

EQUIVALENT HYDRAULIC PRESSURE

The proper value for the equivalent hydraulic pressure of concrete to use in form design has been variously estimated all the way from 75 lb. per square foot per foot of depth to twice that amount. The value of 140 lb. will give safe results and is based on actual experiments under job conditions. We have recently made three tests of concrete pressure on wall forms. Two of these were in a 20-in. wall, cast at the same time as the floor slab. The third was in a 6-in. partition wall, cast after the slab had been stripped.

The results of the first two tests seemed to indicate that the maximum pressure came when the head was about 3 ft. and diminished or remained constant thereafter. This was due to the fact that the wall could not be poured faster than 3 ft. in height in 30 min. and the concrete rapidly lost some of its hydraulic effect after this time had elapsed. Up to the time the mercury column began to fall, the pressure was 130 lb. The test on the partition wall gave an average of 125 lb. per square foot. This wall was built in about 25 min. In this test also the gages showed a decrease in pressure after about 30 min. The rate of filling the form should be considered in selecting the design head.

It should be noted that as a rule the head of concrete in a wall is limited by the height that can be cast by the placing outfit in one hour. Ordinary concrete begins to set up in this space of time so as to lose much of its hydraulic effect. It is economical when high heads occur to limit the height to which the concrete can be cast in order to use lighter forms. A system which requires a large number of rod or wire ties is decidedly uneconomical.

POINTS IN ORIGINAL DESIGN

Stock sizes of lumber should be kept in mind when dimensioning the concrete members. For example, projections should be made 1½ and 1¾ in. instead of 1 and 2 in., since the dressed stock comes nearer the former sizes. Beams can be made 11¾ in. wide instead of 12 in. Thus one 12-in. plank can be used without needing a ¼-in. strip tacked to the edge. Points such as these, thought out in the designing room, mean a cheaper building.

It is the writer's opinion that more accidents can be prevented, and money saved by contractors and for owners by showing the same interest in the study of form work as in the reinforced-concrete design. The greatest proportion of the small number of failures in concrete structures is due to either faulty form design or too early stripping.

The unit cost of making a thorough study of forms for a job is difficult to determine, but it is small compared to the time saved in the field by using the more efficient methods. In spite of the fact that carpenters' wages have steadily increased, while the quality of labor has decreased, and a poorer grade of lumber costs more than a few years ago, unit costs on form work now are much lower than when the job was left to itself. The overhead cost for this office work is a very small part of the total unit cost of the form work.

Concrete Deformations Increase with Time

Result of Long Time Tests of Three Compression Specimens Shows Importance of Time in Measuring Stresses in Buildings

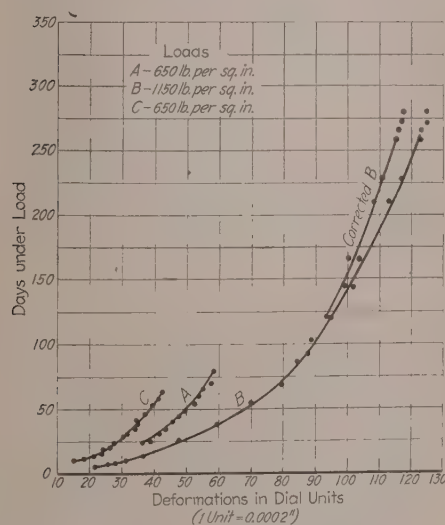
By ALMOND H. FULLER,

Dean of the College of Engineering,
and CHARLES C. MORE,

Professor of Civil Engineering, University of Washington

IN MAKING a recent test (April, 1915) of a reinforced-concrete building, the writers found concrete deformations in the building which greatly exceeded those in the laboratory tests under, presumably, approximately the same unit stresses. It was found, further, that the deformations in the building increased during the few days that the maximum test load was allowed to remain. It seemed probable, therefore, that the time element should be considered in interpreting the stresses, but a search in available literature failed to disclose any data on the subject.

[Since this time the results obtained by F. R. McMillan have been published in "Studies in Engineering, No. 3," University of Minnesota, abstracts of which will be



DEFORMATIONS INCREASE WITH TIME

found in the Engineering Record of April 17, 1915, page 489, and Aug. 28, 1915, page 251.]

Use was made of three available compression specimens in applying increments of load at intervals of twenty-four hours at approximately the same rate as in the building above referred to. The accompanying diagram shows the relation between days under load and deformation during the periods that the three specimens, A, B and C, were under constant load.

It seems apparent that the modulus of

elasticity as a measure of the relation of stress to deformation while the load is being applied or released is of doubtful value in determining the stresses that are represented by observed deformation in concrete that has been under load for a considerable period of time. However, the modulus of elasticity as a measure of the relation of stress to deformation as determined from time tests in which the rate of application is the same would furnish means for making a fairly satisfactory determination of the existing stresses.

The standard to which the readings have been referred is a steel bar bedded in concrete, therefore the results show the total deformation in the concrete, including shrinkage, effect of humidity, etc. In presenting these few results at this time it is realized that they are entirely inadequate for use other than on the building in question. It is believed, however, that they indicate that the elasticity of concrete must be recognized and that the distribution of stress between steel and concrete in reinforced-concrete structures may be quite different from that usually assumed. It is hoped that the discussion may bring out the results of other work done along this line.

Reinforced-Concrete Tower Tank 172 Feet High

Middleboro (Mass.) 500,000-Gallon Water Tank Built with Hemispherical Bottom and Supported on Cylindrical Tower

By G. A. SAMPSON

Of Weston & Sampson, Consulting Engineers, Boston, Mass.

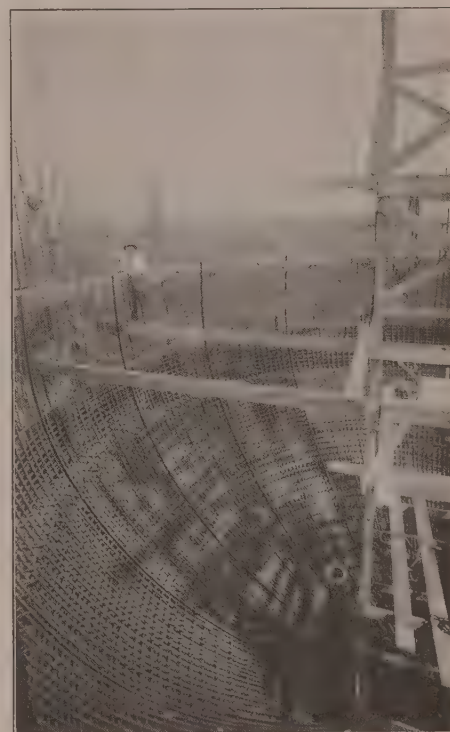
THE aim of this paper is to present the main features of the design and construction of the Middleboro (Mass.) tower tank, the largest elevated water tank in the United States and the first to be built with a hemispherical bottom.

A hollow cylindrical tower was adopted in preference to a number of columns because, structurally, it seemed a safer type of support, would probably be more economical to construct, and could be designed to present a more pleasing appearance. The simple cylinder is relieved by twelve 4 x 24-in. pilasters. The thickness of the tower wall between pilasters is 10 in. and the greatest compression due to the dead load is 483 lb. per square inch, increased by wind pressure to 631 lb.

TANK HAS HEMISPHERICAL BOTTOM

The 500,000-gal. tank is 41 ft. in inside diameter and has a depth of water at the center of 59 ft. The bottom is a hemispherical bowl hung at its rim from the wall of the tower. The bowl itself has a capacity of 125,000 gal. The advantages of this type of bottom over the flat beam and slab construction often employed for small tanks, and the dome type used in a few structures of considerable size, are great enough to warrant careful consideration in the design of elevated concrete tanks. As compared with the dome bottom, there is a saving of 34 per cent in the height of the vertical wall of the tank for the same capacity, or a 47 per cent increase in capacity for the same height of wall. It has a practically self-cleaning bottom. There is a better distribution of stresses because the enormous thrust in the dome bottom, which is concentrated at the most critical point of the tank, is replaced by a uniform tensile stress.

The vertical wall of the tank varies in thickness from 10 in. at the top to 16 in. at the bottom, and the hemispherical bottom from 18 in. at its connection with the tank walls to 14 in. at its center. Without any assistance from the steel reinforcement, the tensile stress in the concrete is about 250 lb. per square inch. The tensile stress in the steel acting independently is approximately 14,000 lb. per square inch. With both materials acting in conjunction, the computed stresses are 215 and 2150 lb. respectively. The tank is covered to guard



HEMISPHERICAL BOTTOM WELL REINFORCED

against the growth of algae and to prevent freezing. The roof is a concrete dome 4 in. thick, with a rise of 4 ft. in the center.

SPECIAL JOINTS IN TANK

To insure watertight construction joints in the tank, there was cast in the old concrete a continuous triangular groove, about 1½ in. deep, running around the wall near its center subsequently filled with grout and concrete; to still further minimize the chance of leakage at each horizontal joint, an uncoated steel plate or dam of No. 14 gage metal 10 in. wide, turned over 1 in. at each edge to form a channel and bolted together to form a continuous watertight stop, was imbedded 4 in. into the old work, thus leaving 4 in. extending up for a bond with the new concrete. The cost of twelve channel rings in place was about \$400.

Water was let into the tank on Oct. 24, 1915, and the depth gradually increased to 26 ft., when three hair-cracks developed radiating from the central 16-in. inlet main and extending 6 to 9 ft. therefrom. The water was drawn off, and a circular reinforced-concrete ring 9 in. thick, bonded to the old bottom by roughening, grouting and dowelling, was cast on the inside of the tank around the pipe. The structure was put into service on Jan. 1, 1916, and although the present depth of water is only about 30 ft., no weakness or leakage has developed. The sole reason for the cracks was undoubtedly the insufficient reinforcement

in the design, and does not reflect on the type of bottom or the workmanship of the contractors.

The vertical wall of the tank, with the exception of three or four small damp spots in one horizontal joint where an excessively hot day caused shrinkage cracks in the top of the ring poured on the previous day, has been absolutely tight, as well as the hemispherical bottom, except for the above-mentioned cracks.

The total cost of the completed structure, including engineering, was \$27,500. The average cost of concrete per cubic yard, excluding reinforcement, was \$18.09; the average cost including reinforcement was \$21.60. The contractor was the Hennebique Construction Company, of New York. Thomas M. Dorsey was resident engineer for the writer, under whose direction the work was designed and constructed.

Construction Methods Tested in DuPont Concrete Road

Experiments Made to Determine Effects of Reinforcement and Hydrated Lime in Preventing Transverse Cracks

By CHARLES UPHAM

Chief Engineer, Coleman-DuPont Road, Delaware

EXPERIMENTS to determine the most suitable methods and materials to use in preventing transverse cracks by means of steel reinforcement and by the addition of hydrated lime, have been a feature in the construction of a 20-mile section of the Coleman-DuPont road in Delaware. No standard length of concrete slab was adopted, as it was decided, in order to learn what the maximum length of slab could be, to place joints only when the concrete mixer stopped for more than 15 min. This has resulted in some very long slabs, the longest being 460 ft. The concrete pavement is 14 ft. wide, 7 in. thick at the center and 5 in. thick at the sides, on a flat subgrade.

THREE KINDS OF REINFORCEMENT

Three different kinds of steel reinforcement have been used. It was the intention to keep the cost and weight of reinforcement per square yard practically the same for all types of construction.

One section of the road is reinforced for the entire width with No. 29 American Steel & Wire mesh reinforcement. This gives the weight of reinforcement per square yard of pavement as 2.52 lb. Wherever the slab was less than 178 ft. long, no cracks have yet appeared.

Another section of the road is reinforced for the entire width with No. 25 Kahn expanded metal. This gives the weight of reinforcement per square yard of pavement as 2.25 lb. Wherever the slab was less than 164 ft. long, no cracks have yet appeared.

The third section of the road was reinforced with No. 25 Kahn reinforcement for a distance of 4 ft. on each side of the center line. More cracks appeared in this section than where the reinforcement extended the entire width of the pavement.

A fourth section was reinforced with the same material as noted in the preceding paragraph for a distance of 3 ft. on each side of the center line. With the exception of one slab, more cracks have appeared in this section than in either of the other reinforced sections.

The sections where no reinforcement was used have developed cracks, but up to the present time not as many as the sections that were reinforced with the 6 and 8-ft. reinforcement. One reason to account for this may be that the unreinforced section has not been laid as long as the others. With one exception it appears that as the percentage of reinforcement increases the transverse cracks become fewer. The increased cost due to reinforcement was 9 cents per square yard.

TESTS WITH HYDRATED LIME

A number of experiments using different amounts of hydrated lime up to 10 per cent by volume were performed. While sufficient time has not elapsed to warrant any definite conclusions, the results promise to be interesting. The only conclusion that can be drawn now as to whether or not the lime is of benefit is from the number of transverse cracks that have developed.

On one section where no lime was used the longest reinforced slab that has not developed a crack is 191 ft. When 10 per cent of lime by volume was used the longest slab to develop no crack was 210 ft. In another instance a slab without reinforcement and using no lime, has developed two cracks, breaking the slab up into three sections, 299, 118 and 126 ft. long, respectively. In two slabs where 10 per cent lime was used no cracks have yet developed; the length of these slabs is 336 and 210 ft.

On another section the longest slab without lime, showing no cracks, was 187 ft. When 5 per cent of lime was used the longest slab without a crack was 245 ft. When 10 per cent of lime was used the longest slab showing no crack was 294 ft. While the data are not sufficient to warrant definite conclusions, they do advocate the use of lime.

Diverse Methods Feature New York Subway Concreting

Both Central and Portable Mixing Plants Used on \$330,000,000 Dual Transit System Contracts

By ROBERT RIDGWAY

Engineer of Subway Construction, Public Service Commission, New York

IN the construction of New York City's new \$330,000,000 dual system of subways, which will increase the single-track mileage from 296 to 620, approximately 3,000,000,000 cu. yd. of concrete, involving 5,500,000 bbl. of cement, are being placed by a variety of methods, involving both central and portable mixing plants. Of the total estimated concrete yardage 1,600,000 cu. yd. were placed prior to Jan. 1, 1916. On account of the magnitude of the work it has been necessary to establish in New York City a laboratory where all concrete materials are passed upon by a specially organized division of the Public Service Commission known as the Division of Materials Inspection.

The plans for the new subways involve many types of structure, such as subways in open cut and in excavation under decking, soft ground and rock tunnel, subaqueous tunnels driven with and without the use of the shields and compressed air, subaqueous tunnels of the Detroit River type, and elevated railway construction of steel and reinforced concrete. The work also involves the underpinning of buildings from one to twenty stories in height.

The methods of mixing and placing concrete are left largely to the discretion of the several contractors. On most of the Lexington Avenue work the contractors preferred to use central mixing plants, which were generally located along the East River where the materials could be brought to them by water, the concrete being hauled, after mixing, $\frac{1}{2}$ mile or so to the work. Where motor trucks were used the time consumed in transporting the mixture was not a cause for concern. Some of these trucks had a capacity of 4 cu. yd. On one of the sections air jets were used instead of water jets to loosen the concrete from the trucks when being dumped. On several of the contracts the concrete was hauled in horse-drawn trucks from the mixing plant, and the time required was long enough to raise a question as to whether initial set was taking place before the concrete could be placed in the forms. Some of the concrete delayed in transit was rejected. Because of the trouble from this source the contractors adopted a plan of mixing the ingredients dry at the central plant and delivering the dry mixture on the street at the work, when water was added and the mixture turned over twice by hand before being placed in the forms.

In spite of the advantages of central mixing plants the author prefers to have concrete mixed as close to the work as possible, for he believes that a better quality of concrete is insured when it can be delivered to the forms immediately after mixing. As most of the streets are decked over the subway openings, the concrete is delivered to the forms through chutes leading from holes cut through the decking. Mixing and placing concrete by a pneumatic method has been tried experimentally on several of the subway contracts.

The Harlem River section of the Lexington Avenue subway was built by sinking steel tubes in sections in a trench previously dredged in the bottom of the river. The steel shells were surrounded with concrete placed under water through tremies and work was carried on in a manner generally similar to that employed in the construction of the Detroit River tunnel. (This work has been previously described in the Engineering Record.)

OLD CONCRETE WELL PRESERVED

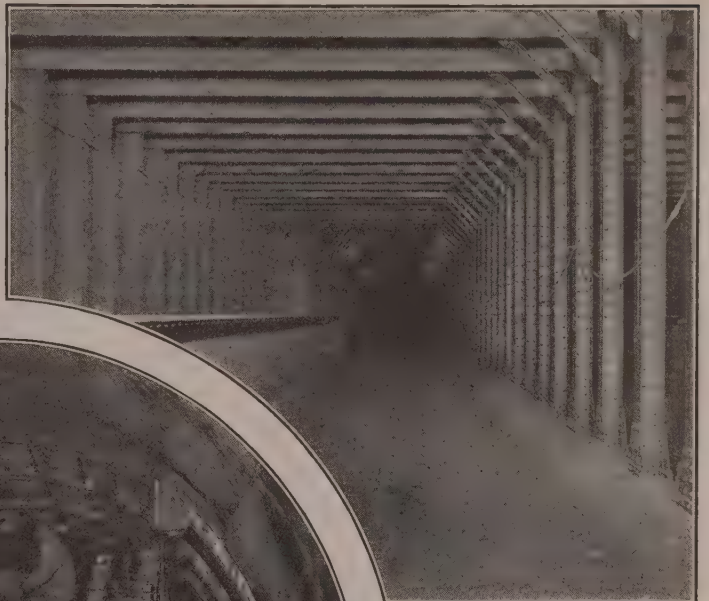
The original Interborough subways which are now in operation were constructed between the years of 1900 and 1906. It has been necessary, from time to time, to lengthen the platforms of the stations to provide for longer trains, to construct ventilating chambers, emergency exits and to make other alterations for various purposes. All of this work involves the cutting out of the original concrete in many places and there has been no evidence of any disintegration of the old concrete from electrolysis or other causes. Two pieces of concrete, thirteen years old, were cut from the lining of the Park Avenue tunnel, sawed into 6 x 6 x 12-in. prisms and tested for compression. One sample failed at 3960 lb. per square inch and the other did not fail under the capacity of the machine, about 4000 lb. per square inch.

In driving the shields for the tunnel which passes under the East River the Manhattan shield encountered the concrete foundation of a bulkhead wall constructed by the Department of Docks and Ferries in 1905. This foundation was in the form of concrete deposited in the salt water in

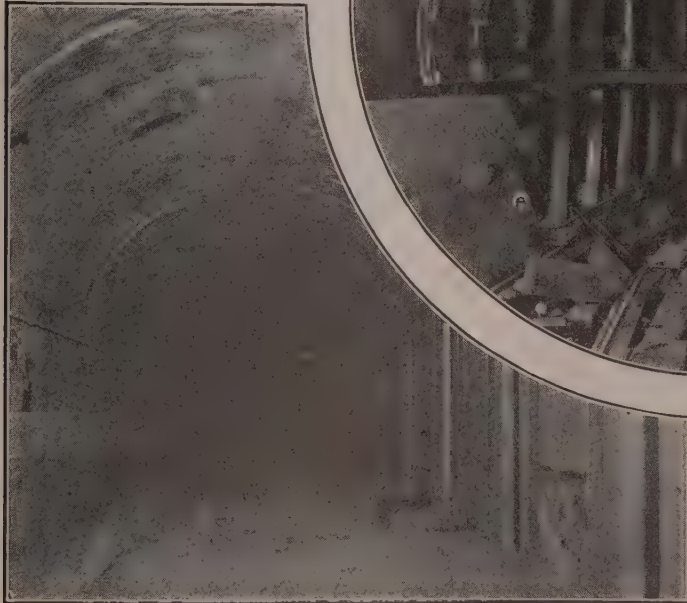
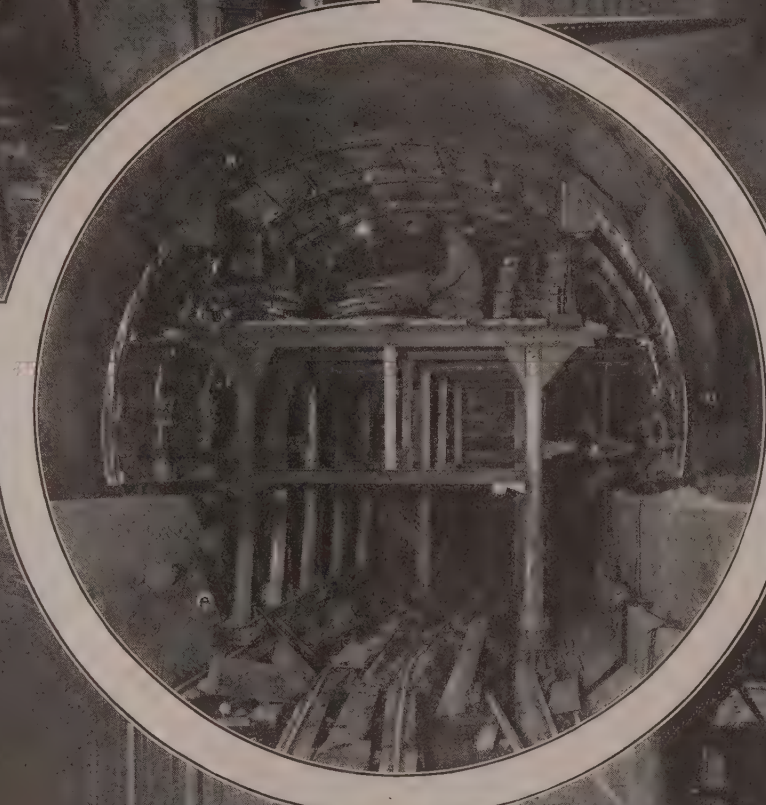
How New York's Subway Work Is Progressing



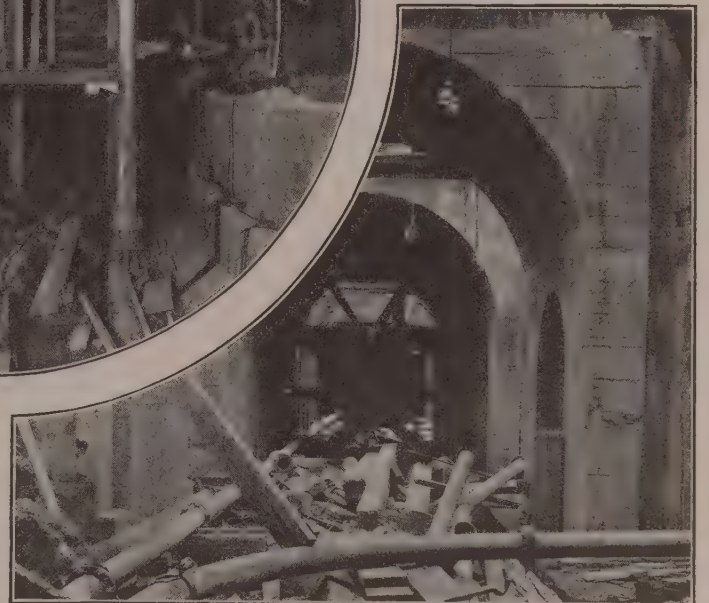
HARLEM RIVER TUNNEL SECTION
READY FOR TRACK-LAYING



PLATFORM OF LOCAL STATION ON
LEXINGTON AVENUE LINE



COMPLETED PORTION OF LEXINGTON AVENUE ROUTE



THIS SUBWAY CONCRETE PLACED BY PNEUMATIC METHOD



ORNAMENTAL REINFORCED CONCRETE STRUCTURE FOR ELEVATED LINES ALONG QUEENS BOULEVARD—(IN CIRCLE ABOVE) FORM-HANDLING PLANT FOR CONCRETE LINING OF VESEY STREET CAST-IRON TUBE

burlap bags and was found to be in excellent condition. The burlap of the bags was intact in places, and the general appearance of the material was that of mass concrete placed in the dry.

Three-Level Concrete Conduit Design Outlined

Special Conditions Encountered in Location of Conduits Complicate the Unusual Design—Expansion Provisions Ample

By FREDERIC H. FAY

Of Fay, Spofford & Thorndike, Consulting Engineers, Boston

THIS PAPER on the Fall River concrete conduits is the very brief statement of a complicated municipal problem in which are involved many questions of sanitation, stream control, mill engineering and city planning, and to which a concrete conduit of peculiar design furnishes the key.

[As this project has already been described in an article in the Engineering Record of Oct. 23, 1915, page 501, only the details of the design of three-level conduit are here abstracted from Mr. Fay's paper.]

THREE-LEVEL CONDUIT DESIGN

So far as is consistent with stability the main three-level conduit has been designed as a reinforced-concrete structure. For a considerable part of its length, however, this conduit is to be built in gravel and other porous material in which the level of ground water will stand nearly at the top of the conduit. In view of the fact that the several conduit channels may all be empty at the same time, the lower section of the structure was designed of massive concrete to give it sufficient weight against possible flotation.

Further, it will be possible, if found desirable, to deposit this mass concrete in water within the walls of a temporary cofferdam, thus sealing the bottom and rendering the unwatering of the cofferdam by pumping a simple and easy matter. Under the program of construction proposed, however, it is planned to dike off that part of the river in which the conduit is to be built, and to carry out practically all the construction in the dry.

Above the mass concrete of the cold-water channel, the side walls and the floor, both of the surface-water and of the hot-water channels, are of thin reinforced-concrete construction. To avoid the objections to an open channel, the hot-water channel is covered by thin reinforced-concrete roof slabs supported on reinforced-concrete cross beams, the roof slabs being removable so that access to the hot-water conduit from the surface may be had at any point.

EXPANSION AND WATERTIGHT JOINTS

The usual provisions for expansion are to be made, care being taken to secure watertight joints. The hot-water channel is exposed at the surface of the ground and, because of this fact and also because it carries an intermittent flow of hot water, is subjected to greater variations of temperature than other parts of the three-level conduit; consequently, provision has been made for the expansion and contraction of the hot-water channel independently of the remainder of the structure. In effect, the hot-water channel with its cross floor is simply supported on the vertical walls of the surface-water channel, horizontal expansion

joints being provided at the top of these walls.

The provision for longitudinal expansion of the surface-water portion of the three-level conduit consists of vertical expansion joints in its vertical walls at intervals of approximately 60 ft. No provision for expansion has been made in the mass-concrete section of the cold-water channel, as this is buried to a depth of 9 ft. below the surface of the ground, the water in it is drawn from a level below the surface of the lake, and no considerable variation of temperature is expected in this mass concrete.

Reinforced-Concrete Slab Tests Show Time Effects

Investigation for Effective Widths of Slabs Carrying Concentrated Loads Also Indicates Increased Deformations with Time

By A. T. GOLDBECK,

Engineer of Tests,
and E. B. SMITH,

Associate Mechanical Engineer, U. S. Office of Public Roads, Washington

IN JUNE, 1912, an investigation was started at the U. S. Office of Public Roads to determine the distribution of stress in reinforced-concrete slabs subjected to concentrated loads. A report on the first six slabs tested was made in June, 1913, before the American Society of Testing Materials. (See the Engineering Record of Aug. 9, 1913, page 154.) During the past two years there have been tested three large-size reinforced bridge slabs to secure data concerning the distribution of stresses to serve as a basis for a reasonable assumption in design formulas. (One of these tests, slab 835, has already been reported in the Engineering Record of Jan. 2, 1915, page 26.)

DESCRIPTION OF SLABS

Each of the slabs herein described was made of 1:2:4 gravel concrete, machine mixed, and was reinforced 0.75 per cent of plain square steel bars, with no transverse reinforcing. These slabs were 32 ft. wide, of 16 ft. clear span with a 10-in. bearing

TABLE 2—EFFECTIVE WIDTHS OF SLABS

Center load, lb.	12-in. slab 835		10-in. slab 930		7-in. slab 934	
	Ft.	Per cent of span	Ft.	Per cent of span	Ft.	Per cent of span
15,000....	...	...	11.4	71.6	12.7	79.5
20,000....	11.6	72.3	13.0	81.2	17.5	109.3
25,000....	11.5	71.9	12.9	81.1	...	...
32,500....	12.1	75.7	...	...	...	...
35,000....	...	...	14.5	90.7	...	...
Safe load	12.1	75.7	12.9	81.1	17.5	109.3

This is not true in the case of concrete, which exhibits a marked flow or molecular adjustment under working stresses extending over time periods of several weeks.

When concrete is subjected to compressive fiber stress of 700 lb. per square inch, the immediate fiber deformation is only about 50 per cent of what it will be if the stress is maintained for three weeks. Within twenty-four hours after the application of the load the deformation has increased an additional 20 per cent; during the first hour the deformation may show a change of 5 per cent or more. Furthermore, the recovery of the deformation after the removal of the load is slow and not complete.

This fact is mentioned here to show the importance of taking all the deformation readings at approximately the same time after the load is applied, and in each case a new set of deformation readings under zero load must be taken just before each load application. The immediate fiber deformation is the value which should be used, and not the value obtained after a long-time suspension of the load, nor that which contains the effect of several applications and removals of loads.

RESULTS FOR EFFECTIVE WIDTH

The determination of the effective width is attended by so many variables that, from the information at hand, a final and definite formula cannot be given. Its value, however, is affected by the span, the total width, the thickness, the load on the slabs, the distribution of the loads, and probably by special forms of reinforcing. The thickness and the load with its distribution are the only variables that have been considered in tests so far, and the values for the effective

TABLE 1—DIMENSIONAL DATA AND BREAKING LOADS

Serial No.	Thickness, in inches		Reinforcing		Modulus of elasticity	Breaking load, lb.	Age, mos.
	Total	Effective	Size, in.	Spacing, in.			
835	12	10 1/4	3/4	10.5	2,900,000	119,000	6
930	10	8 1/2	3/4	8.87	4,000,000	80,000	5
934	7	6	1/2	5.56	3,000,000	40,000	3

width on each support. The accompanying Table 1 gives the dimensions and the breaking loads.

The forms were removed at the end of two weeks, and each slab was cured in air and sprinkled once each day until the forms were removed. Tests were begun at the age of about twenty-eight days and were continued periodically until the time of breaking, at the age given in the table.

TIME ELEMENT IMPORTANT FACTOR

One of the important facts which these tests have brought out and which this paper seeks to impress upon concrete engineers, is that the time element is a very large and important factor in determining stress values and their distribution from the fiber deformation. Nearly all other materials of construction will show an approximately constant relation, independent of the time, between the load and its accompanying deformation within the limit of elasticity.

widths for single concentrated loads are collected in Table 2.

From these values it may be noted that there is a general tendency for the effective width to slightly increase with the increase of load. Also, the effective width seems to vary inversely as the thickness of the slab. In the light of the information available at the present time, we should be safe in using a value for the effective width equal to 0.7 of the span.

This series of experiments has not been completed, but is being continued with the hope of arriving at a definite formula for determining the value of the effective width as influenced by all of the important variables.

[The paper by E. B. Smith, entitled "The Flow of Concrete Under Sustained Load," giving the results of additional tests supplementing the above will be published in a succeeding issue.—EDITOR.]

Creosoting Plant at Orrville, Ohio, Has Vertical Cylinders for Wood Blocks

Comparatively New Idea Is Believed to Have Many Points in Its Favor, Economizing in First Cost, Labor and Space

By E. A. STERLING

Manager, National Lumber Manufacturers' Association, Chicago

A COMPARATIVELY new idea in the process of creosoted wood block has been developed which is of great importance, because it promises to reduce materially the cost of wood block. The new idea is mainly one of economy in operation, which is certainly a practical measure when properly applied, and worthy of consideration, because it does not involve

planing mill and shop are all housed in separate buildings. Steam is generated in two boilers of 150 hp. each, with steam at from 100 to 150 lb. working pressure, and so fitted that either coal, wood, refuse or gas may be put in as fuel at any time. The electric current is furnished by a local power plant, and all the woodworking machinery is driven by direct-connected

blocks in a vertical type of cylinder may be summarized as follows:

1. There is a reduction in the amount of labor, owing to the mechanical handling of the blocks from the saws to the outbound cars.

2. Lost space is reduced to a minimum, permitting in each charge more cubic yards of blocks per unit of cylinder displacement than is possible in a horizontal cylinder, where block baskets or cages are necessary.

3. The vertical cylinders require only one-tenth of the ground space used for the horizontal type of plant.

4. The first cost of the entire equipment is very materially less than that of a treating plant with horizontal cylinders.

LOW FIRST COST

Perhaps the chief advantage of the vertical block plant from the standpoint of the lumber industry is its simplicity of operation and its low first cost. Only two machines are required, and much smaller tanks and cylinders, thus permitting the construction of paving-block plants in connection with sawmills, or near consuming points. Freight rates on shipments of blocks to remote territory may thus be



CYLINDER FILLED WITH BLOCKS, READY TO BE CLOSED

any new or untried methods of impregnation, nor of preservative material. It is, in short, the vertical cylinder. Two engineers, working independently, have evolved practically the same fundamental idea in the matter of vertical treating cylinders. The first to design and build a plant of this character was J. B. Card, of Chicago. He was followed by G. B. Shipley, of Pittsburgh, who is more recently in the field with a new plant embodying all the improvements and advantages which present experience makes it possible to apply to the vertical-cylinder idea. Since the designs are patented, both of the gentlemen concerned have expressed their willingness to have descriptions published and the information made available to the lumber-trade, wood-preserving and engineering interests. The following describes more specifically Mr. Shipley's vertical plant at Orrville, Ohio:

THE ORRVILLE PLANT

The vertical wood-block cylinders at Orrville have been installed by the Ohio Wood Preserving Company, in conjunction with their horizontal cylinder, which is of the usual type for the treatment of ties and other classes of material. Each type of cylinder is equipped for the use of any standard process, using either creosote or zinc chloride, but, because of the greater economy through the elimination of the wood-block cages necessary in the horizontal cylinder, and the mechanical handling of the blocks from the planing mill to the cars, the vertical cylinders are so far devoted entirely to wood-block treatment. The boiler house, horizontal cylinder building, vertical cylinder equipment,

PLUNGER PUSHING TREATED BLOCKS OUT OF CYLINDER



alternating-current motors, while the crane is driven by direct current.

The plant contains a number of special machines which have been designed and developed to effect the highest efficiency in operation. These improvements have proved entirely satisfactory, and have eliminated many of the operating labor problems of the old type of wood-preserving plant.

The vertical cylinders for treating paving blocks are of two sizes, one holding 300 yd. and the other 200 yd. Each cylinder is fitted on the inside with a hydraulic plunger and platform, so that when empty and about to be charged with wood blocks the platform is at the top, and as the blocks are delivered into the cylinder the platform lowers gradually, thus preventing breakage. When the cylinder is full the top cover or door is put on and the blocks are treated in the usual manner. After treatment, when the cover is taken off and the plunger started, the treated blocks are forced up and discharged into a chute and direct into cars for shipment.

APPARENT ADVANTAGES OF SYSTEM

Without going into further details the apparent advantages of treating wood

eliminated, making it easier to meet the competition of other paving materials. In many localities the cost of wood block has been almost prohibitive on account of the long haul, a factor which can be largely eliminated if inexpensive vertical block plants can be erected in regions which it is now possible to serve only from distant plants. Another consideration is that the capacity of the plant may be more readily adjusted to the needs of the locality, the size and number of cylinders being readily adjusted or changed.

If the point has actually been reached where a vertical type of plant will materially reduce the cost of treatment, and the equipment is so simple in character and so low in cost that it can be installed in connection with existing treating plants or sawmills, where power is already available, it should greatly help to develop the wood-block industry in all parts of the country. This development in turn would create a demand for Southern pine in the South, tamarack in the North and fir on the Pacific Coast, or any other wood suitable for wood-block pavement. At the same time it would permit the use of this superior paving in cities and towns where previously its cost had prevented its use.

The vertical type of plant is also adapted to treat material other than blocks, so that local requirements may be taken care of, or material treated for retail trade. The smaller dimensions of timbers, silo stock and bridge material can be rapidly treated by loading them on the movable platform which can be pushed up to take the load and lowered so as to immerse it in the cylinder.

The cylinders are operated by combined air compressor and vacuum pump, thus reducing all piping to a minimum. All measuring tanks are also vertical and mounted on weighing scales, so that the exact amount of preservative absorbed by the wood is determined directly on the basis of weight, instead of by the old

Building Districts and Restrictions to Be Based Upon Definite Principles

New York City Commission Working on Plans for Regulating Height of Buildings, Area of Courts and Location of Trades

THE COMMISSION on building districts and restrictions appointed by the Board of Estimate and Apportionment of New York City to report on a districting plan regulating the height of buildings, the area of courts and yards, and the locations of trades and industries has recently issued a progress statement of the plans under consideration. It contains the definite principles on which the work is to be

erty. One purpose of districting regulations is to do for the individual owners what they cannot do for themselves—set up uniform restrictions that will protect each against his neighbor and thus rebound to the benefit of all.

HEIGHT AND AREA DISTRICTING

Rentable values in any given block or area are largely dependent on a certain measure of uniformity in its development as regards height, yards and open spaces. There can be no security or stability of values if each individual owner is at liberty to build to any height and over any proportion of his lot without regard to his appropriate and reasonable contribution to the light and air of the block.

This has been conclusively demonstrated by costly experience in the recent history of the office and loft-building sections of Manhattan. Whole areas have been built up piecemeal with towering buildings having inadequate courts and yards without much thought of ultimate consequences. Such areas are in process of being smothered by their own growth. The streets are inadequate to handle the traffic induced by the multiplication of floor area to be served, and the buildings, constructed without reference to the width of the streets, yards and courts on which they abut, shut out light and air essential to rental on a basis that will permit of a fair return on the investment.

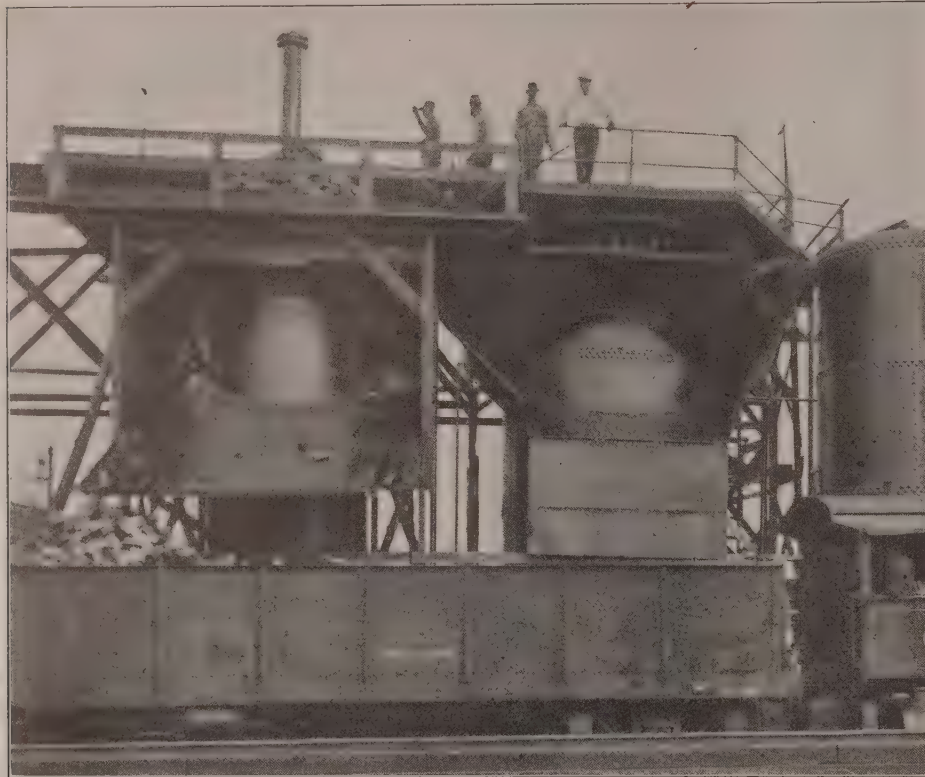
BASIS IN INTENSITY OF DEMAND

A proper districting plan would insure that wherever probable intensity of demand will permit, a certain measure of the improved light and air conditions that have attracted tenants to the new locations shall be permanently retained. In establishing air and light provisions the district plan will not usually go as far as, and will in no case go farther than, the purely economic standard indicated by the mutual advantage of the property owners and tenants and the conservation of the property values.

A districting plan should look to the future and take into consideration the types of development appropriate for the increasing intensity of use required by a growing city. To avoid the continuous reconstruction of existing buildings and the evils and misfits often resulting from the conversion of old buildings to new uses, it is undesirable to base a districting plan on the type of construction appropriate to the present-moment intensity of use. As the city is growing, that fact should be taken into consideration and types of construction authorized appropriate for any intensity of use that will probably be demanded and be socially justifiable within twenty-five or fifty years. A city that is not built with reference to probable future growth must be rebuilt time and again at enormous expense.

USE DISTRICTS

In a residential district only buildings with their usual accessories designed for the following specified uses may be con-



TREATED BLOCKS BEING EJECTED AND DROPPED DOWN CHUTE INTO CAR

volumetric measurements which required temperature adjustment.

The blocks are cut with an automatic band saw running on ball bearings, and driven by a direct-connected motor. The machine can be adjusted for different capacities, although it is generally used with eight saws, which easily cut 70 yd. of blocks an hour.

TO PROTECT BOTTOM FLANGES of girders over railroad tracks from the rapid deterioration due to the chemical action of smoke and gas, together with the erosive effects of engine blasts, it was found, after trying several other devices, that $\frac{7}{8}$ -in. plain oak sheathing held firmly in place by iron clamps, the sheathing being first covered on its upper side by a paste composed of red lead and Portland cement, was very satisfactory. As stated by L. M. Hastings, city engineer of Cambridge, Mass., in the February *Journal* of the Boston Society of Civil Engineers, the oak sheathing showed surprising resistance to the destructive action of the blast. Some pieces of oak taken from the bridge after 10 or 12 yr. exposure showed a loss of thickness of not more than $\frac{1}{4}$ in.

done. The following is an abstract of the more important of these principles relating to the justification for districts and to the basis for the limitations:

DISTRICTING FOR USE

Generally speaking, a building is appropriately located when it is in a section surrounded by buildings of similar type and use. Strong social and economic forces work toward a natural segregation of buildings. In general, the maximum land values and the maximum rentals are obtained where the segregation and uniformity are most complete. The chief purpose of districting regulations is to strengthen and supplement the natural trend toward segregation.

In spite of this natural trend, building development in many parts of a big city is haphazard. The natural trend is not strong enough to prevent sporadic invasion of a district by harmful or inappropriate buildings. Once a district has been thus invaded, rents and property values decline, and it is difficult ever to reclaim the district to its more appropriate use. Individual property owners are helpless to prevent the depreciation of their prop-

structed: Residential, hotels, private clubs, religious, educational, curative and philanthropic buildings and institutions. In a business district a list of justified industries and uses of a clearly objectionable character are excluded, as are also all other uses that are not noxious or offensive by reason of the emission of noise, odor, dust or gas.

The larger type of factory is excluded from the business districts by the limiting of the floor space that may be occupied for factory uses in any one building in a business district to 25 per cent of the total floor space of the building, but floor space equal to twice the ground floor area of the building may in any case be so used.

The proposed regulations apply only to future buildings and uses, and do not interfere with any existing structure or occupancy. The parts of the city not included in the residential or business districts are left unrestricted as to use. In residential neighborhoods the plan has been to preserve the side streets, wherever feasible, for strictly residential use. The avenues along the ends of the block and the main thoroughfares have usually been included in the business districts.

HEIGHT DISTRICTS

Five classes of height districts are provided, limiting the height of the building at the street line to a varying multiple of the street width. These multiples vary from $2\frac{1}{2}$ in the office and financial section of Manhattan to 1 in the more undeveloped sections of Brooklyn, the Bronx, Queens and Richmond. Back of the street wall, the height of which is limited by a multiple of the street width, the building may go higher, but not beyond the line formed by the extension of the line drawn from the center of the street to the limiting height of street wall. This will permit the construction of mansards or of vertical walls, provided they are set back in a prescribed ratio so as to keep within the set-back provisions.

In limiting the height of all buildings in relation to width of streets the commission has adopted a principle which has been applied to tenement-house construction in New York City since 1885. It has also been extensively applied in European cities. It has evident advantages over a flat limitation that operates without regard to the street. The commission has, however, modified the strict application of this principle by providing that for the purpose of computing the limiting height a street less than 50 ft. wide shall be considered to be 50 ft. wide, and a street more than 100 ft. wide shall be considered to be but 100 ft. wide.

The only district in which the height of $2\frac{1}{2}$ times the street width is proposed is in the section of lower Manhattan, south of Leonard Street and Brooklyn Bridge Plaza between Church and Pearl Streets. A width of two times the street width is allowed for the remaining parts of the more intensely developed commercial and industrial section in a broad belt through the center of the island from Leonard Street to Fifty-ninth Street between West Broadway, Seventh or Eighth Avenue and Third Avenue or Lexington Avenue. An exception is made for part of the Fifth Avenue section where limits of $1\frac{1}{4}$ and $1\frac{1}{2}$ times the street width are proposed. A width of two times the street width is

also allowed for a narrow belt along part of the North River waterfront of Manhattan and along the East River waterfront of Brooklyn, Queens and the Bronx.

YARD AND COURT REQUIREMENTS

In establishing districts limiting the percentage of the area of the lot that may be covered by the building, and prescribing minimum yards and courts, the commission has attempted to insure that each owner shall make a reasonable contribution to the light and air of the block. The plan has been based, first, on the partial segregation of buildings according to use districts, and second, by the gradation of court and yard provisions, particularly as affecting residential buildings, in accordance with the present and prospective intensity of use in various sections of the city.

Five classes of area districts are proposed, fixing varying percentage of lots that may be covered and corresponding regulations as to courts and yards. These are called the 100, 90, 80, 50 and 30-per cent

observers for storm-water flows and for his sewerage investigations. Previous to his incumbency the city light and power plant was almost the only department to use the students under this scheme.

Undermined Asphalt Pavement Withstands Unusual Stresses

IN southern California the State Highway Commission has laid the concrete pavement in many districts with shoulders 3 ft. wide and 3 in. thick, composed of crushed-rock aggregate up to $\frac{1}{2}$ in. in size mixed with hot asphalt. The concrete base of the road is laid only under the central part, so that these shoulders overlie only a crushed-rock base.

When the unprecedented January floods swept down from the mountains, natural channels were overflowed and the highways suffered their share of the damage. The accompanying photograph shows a section of the boulevard east of Pomona over which the waters poured for the greater part of



WATER FLOWED OVER THIS UNDERMINED PAVEMENT FOR THIRTY-SIX HOURS

classes. In each case the court and yard requirements and the limitation of area covered is more stringent for residential buildings than for non-residential buildings.

Edward M. Bassett is chairman and Dr. Robert H. Whitten, secretary of the commission. George B. Ford is consultant. The tentative maps for each of the boroughs of the greater city can be inspected at the office of the commission in the Municipal Building, New York City.

Public Works Scholarship Fund Helps City

THROOP College of Technology, Pasadena, Cal., has a scholarship fund which enables it to help the city with technical students without any expense to the city. A "public works scholarship fund" has been provided by a resident of Pasadena and is administered by Prof. R. W. Sorensen. For purposes for which no appropriations are made by the city a city official can obtain students from the college, approve their time slips and know that they will be paid from the interest or principal, part of which becomes available annually. The present city engineer, R. V. Orbison, has been making use of the opportunity to get good

two days. At this particular point the overflow cut a deep ditch along the road and undermined the pavement for a distance of about 3 ft. back from its outer edge.

The asphalt compound withstood a flood ranging up to 10 or 12 in. deep for a period of thirty-six hours, showing no signs of failure after the waters had subsided to normal. Unfortunately, highway officials could not obtain workmen in the flooded district during and immediately after the storm, as all available men had been drafted into service by the various properties threatened, and only the regular highway force could be depended upon for repair work. With the available forces an attempt was made to shore up the overhanging pavement, but before this could be properly done the sun came out and softened the asphalt to such a degree that the unsupported sections collapsed.

SCRAP MATERIAL sold by the Pennsylvania Railroad during 1914 brought \$2,157,241.24, which is \$1,000,000 less than was obtained by the same means in 1913. Some of the items and amounts were as follows: Old wheels, metals and wrought iron, \$780,000; locomotives and wooden passenger cars, \$114,326; waste paper, \$19,211; oil barrels, \$22,439; old rubber, \$15,222.

Nation-Wide Canvass by Experts Sifts Out Best Methods of Concrete Road Building

Abstracts of Some of the Committee Reports Presented at the National Conference on Concrete Road Building Held in Chicago, February 15 to 18

Proportions of Materials and Consistency of Concrete

Committee—W. S. Gearhart, chairman, Kansas State Engineer; A. N. Talbot, professor of municipal and sanitary engineering, University of Illinois; W. M. Acheson, division engineer, New York State Highway Commission, Syracuse, N. Y.; H. S. Van Scoyoc, chief engineer, Toronto-Hamilton Highway Commission; F. L. Rice, F. L. Rice & Sons, Shelby, Ohio.

IT is the common practice at the present time to proportion materials for concrete roads and streets by the method of "arbitrary selection"; that is, by specifying the number of parts of different ingredients.

The general adoption of a more scientific method of proportioning the materials is very much to be desired. The committee appreciates the practical objections to such a change, but with the hope that the present method may be improved wishes to call attention to the sieve-analysis method of studying the character of aggregates and the proportioning of materials devised by W. B. Fuller. By this method, the densest mixture of the aggregates to be used can be accurately and readily determined; and often considerable economy may be effected by varying the proportions without injuring the quality of the concrete.

Your committee's recommendations for the proportions of the several classes of concrete for roads and streets represent the best practice at the present time. However, they should not be used without a thorough appreciation of the defects in the method of arbitrary selection.

For a one-course concrete pavement the materials should be mixed in the proportions of 1 sack of Portland cement, 2 cu. ft. of fine aggregate, and 3 cu. ft. of coarse aggregate. A cubic yard of the resulting concrete in place should contain not fewer than 6.8 sacks of cement.

For the base of a two-course pavement the materials should be mixed in the proportions of 1 sack of Portland cement, $2\frac{1}{2}$ cu. ft. of fine aggregate, and 5 cu. ft. of coarse aggregate. A cubic yard of the resulting concrete in place should contain not fewer than 5.6 sacks of cement.

If the base is to consist of cement and fine aggregate the materials should be mixed in the proportions of 1 sack of Portland cement to not more than 4 cu. ft. of fine aggregate. A cubic yard of the resulting concrete in place should contain not fewer than 8.2 sacks of cement.

For the wearing course of a two-course pavement the materials should be mixed in the proportion of 1 sack of Portland cement to not more than 2 cu. ft. of fine aggregate. A cubic yard of the resulting concrete in place should contain not fewer than 11.8 sacks of cement.

Whenever it is economical to do so the materials in the wearing course should be mixed in the proportions of 1 sack of Port-

land cement, $1\frac{1}{2}$ cu. ft. of fine aggregate, and $2\frac{1}{2}$ cu. ft. of coarse aggregate which would be retained on a $\frac{1}{4}$ -in. mesh sieve and which would pass a $\frac{3}{4}$ -in. mesh screen, in order to reduce the difference between the expansion and contraction in the base and wearing courses to a minimum.

Many experiments in concrete road construction have been made recently with hydrated lime added to the concrete in amounts ranging from 5 to 10 per cent by weight of the cement. Information available at the present time seems to indicate that the addition of a small percentage of some inert material such as hydrated lime may be of value in concrete road construction, for it decreases the percentage of voids and produces a more impervious concrete, and reduces the expansion and contraction under moisture changes; but at this time the committee does not feel warranted in making any definite recommendations.

Wet, slushy concrete has many disadvantages. The consistency of concrete for road or street work should be such that when deposited from a chute or bucket it will settle in a flat mass, but will not flow on the subgrade. No tamping should be required and no separation of the mortar from the coarse aggregate should occur in handling the concrete or in finishing the surface.

The hauling of concrete in carts from the mixer a distance of from 300 to 500 ft. is not considered advisable and in accord with good practice.

Drainage and Preparation of Subgrade

Committee—Hector J. Hughes, chairman, professor of civil engineering, Harvard University and Massachusetts Institute of Technology; Clinton Cowen, state highway commissioner, Columbus, Ohio; George W. Cooley, state engineer, Minnesota State Highway Commission, St. Paul, Minn.; George A. Quinlan, county superintendent of highways, Chicago; Edward T. Beck, Edward T. Beck & Co., contractors, Cuba, N. Y.

EXPENDITURES on preliminary investigations of road drainage are, in the end, a real economy. Neglect of this factor means increased cost of construction, permanently poor roads and large maintenance charges. Excavations for drainage should be definitely and carefully arranged for in the specifications, and executed with as much care as any other part of the work.

Road drainage in general involves the disposal of, (1) surface water flowing to the road from outside areas; (2) rain falling on the road itself; and (3) underground water from outside areas. Problems of road drainage should be approached with the fundamental idea that to be effective in protecting the road surface a drainage system must be capable of acting quickly. Un-

derdrainage is of necessity slow drainage as compared with surface drainage; every reasonable provision should be made to dispose of surface water coming to the roadway by surface drainage, and to keep it out of the foundation. The conditions imposed by the location often make it necessary that surface water shall be handled by underground channels or even underdrains; but in such cases the underdrains should be proportioned for storm-water capacity and not as for underdrainage alone.

The most obvious and effective way to dispose of surface water coming from outside the road is by means of surface ditches dug outside the top of cuts or along the toes of fills, on one or both sides. Ditches and gutters should be of liberal capacity. Gutters immediately adjacent to the traveled surface should be broad and shallow, rather than narrow and deep.

The kind of soil, the lay of the land, the amount of water, and other local conditions, such as the availability of suitable materials, will determine the method of underdrainage to be employed. The choice would in general be from among the following: (a) Pipes of vitrified clay or cement concrete laid in trenches, backfilled with the material excavated from the trenches, that is, "farm drains." (b) Pipes laid in trenches backfilled with broken stone, gravel, cinders, or similar open material. (c) Trenches filled with stone or gravel, without pipes, "blind drains." (d) Layers of cinders, gravel, broken stone or similar material varying in thickness from a few inches to 12 or 15 in., under the entire road surface. (e) A layer of similar material laid in a shallow longitudinal trench with the cross-section of a flat letter V, and known as "V" drains. (f) Two or more of these methods used in combination.

Of the three types of trench drains, a pipe covered with coarse gravel or similar filling, for the whole depth of the trench, is the most effective. It will act more quickly than the farm drain, or the blind drain; has more capacity, other things equal; and it serves quickly to take care of that part of the surface water that in most cases eventually gets into the ground.

Pipe drains smaller than 4 in. in diameter should not be used. Drains should be laid at least $2\frac{1}{2}$ to 3 ft. below the subgrade, and 4 ft. is often better. Unless the drain is laid to sufficient depth it will not lower the water sufficiently under the entire roadway; but rather than increase the depth much over 4 ft. it is usually better to lay additional underdrains.

Drains in trenches should be laid parallel to the center line of the road on the side from which the underflow comes, or one line on each side; or a succession of transverse lines may be laid at a sloping angle across the road. Cross trenches are likely to form weak spots under the concrete, owing to the difficulty of getting them properly backfilled, and they should if possible

be placed outside. It is desirable to lay underdrains as long as possible before building the road surface, especially if the concrete is to be laid late in the autumn. In many instances a layer of sand, gravel, stone, or cinders has been found to work more satisfactorily than drains in trenches. The committee believes that in very wet foundations the most effective method is a combination of two of the above types, such as pipe laid in trenches 3 ft. deep, more or less, at each side of the road and draining into catch basins or culverts in city streets at or under the curb, otherwise in the shoulder, just outside the ends of the concrete, the trench to be backfilled with coarse gravel, cinders or broken stone. In addition the whole subgrade under the concrete should be covered with a layer of similar material or sand, which makes with the trench filling a continuous drain as well as an insulation for the concrete. Where such loose material is not available, lateral drains laid at depths of 12 to 18 in. at intervals of 20 to 40 ft. across the roadbed from the side drains and draining into them, may serve the same end. The problem is to keep the subgrade dry by the use of such resources and material as are available.

Handling and Hauling Materials and Water Supply

Committee—T. R. Agg, chairman, professor in charge of highway engineering, Iowa State College; H. G. Shirley, chief engineer, Maryland State Roads Commission; Edward N. Hines, chairman, Board of County Road Commissioners, Wayne County, Detroit, Mich.; R. N. Waid, division engineer, Ohio State Highway Department; E. H. Cowan, vice-president, Farrell Engineering & Construction Co., Cleveland, Ohio.

FOR hauling concrete road materials, the following equipment is employed and each type has a distinct field of usefulness:

For hauling in congested districts and for city paving work, the team-drawn truck and the motor truck are available. Neither has an advantage over the other as regards keeping the aggregates clean. The motor truck will prove more economical if the haul exceeds about 2 miles.

The tractor train can be used economically for hauls exceeding about 1 mile, but usually cannot be operated over paved streets, and is not economical unless the hauling is over fairly good roads. Its capacity is relatively small, and it is hampered by unfavorable weather conditions more than any other type of hauling equipment. It is not suitable for paving work except under unusual conditions. It has no advantage over the other types of hauling equipment as regards keeping the aggregates clean.

The industrial railroad is adapted to conditions where loading facilities are ample and where the haul exceeds about 2 miles. It is quite flexible as to capacity, is not hampered greatly by weather conditions and is probably the most economical method of hauling. Under suitable conditions it has the advantage of enabling the materials to be handled without danger of becoming dirty.

Aggregates are most economically handled by unloading from railroad cars by means of the locomotive crane, the bucket elevator or the belt conveyor. Hauling is

greatly facilitated when ample storage is provided of such a nature that the hauling equipment can be loaded quickly.

The water supply system for the concrete road should be such as to insure an abundance of water, and a pipe line along the road is the most convenient means of distribution. If the water is piped for more than a mile the pipe should be not less than 2 in. in diameter; but in any case hydraulic computations can be made to determine the proper size. For all ordinary purposes a 2-in. pipe seems adequate. The pump may be any suitable type designed to furnish not less than 250 gal. per minute. The power requirements will vary with the head, but the 5 or 6-hp. gas engine is commonly employed and is adequate except where the static head is excessive.

Economical Widths of Pavements and Shoulders

Committee—J. J. Cox, chairman, instructor in civil engineering, University of Michigan; W. W. Marr, chief state highway engineer, Springfield, Ill.; A. J. Rockwood, consulting engineer and contractor, Rochester, N. Y.; W. A. Stinchcomb, county surveyor, Cuyahoga County, Cleveland, Ohio.

A SINGLE-TRACK concrete road is generally uneconomical. Where traffic demands a hard-surfaced highway, like that obtained with Portland cement concrete, this traffic also demands a double-track road. The minimum width of concrete roads should be 15 ft.

Economy can be practised by building all shoulders to concrete roads from the native soil. As to widths of shoulders, 5 ft. should be the minimum; no width less than 4 ft. is satisfactory under any conditions. The minimum width of any road grade, even when provided with a single-track concrete road, should be 20 ft.

The use of such materials as crushed stone and high-grade gravel to surface the shoulders of a concrete road are uneconomical. They do not readily consolidate under the light traffic to which they are subjected. They form in ruts and prohibit perfect surface drainage, and do not accomplish the purpose desired. Greater economy will be obtained by putting the extra expense of constructing metal shoulders into extra widths of concrete. The only exception to this statement is where the road happens to be so located that a good consolidating gravel can be obtained at low cost.

Problems of Design, Thickness, Crown and Grade

Committee—Ira O. Baker, chairman, professor of civil engineering, University of Illinois; Thomas H. MacDonald, highway engineer, Iowa State Highway Commission; H. L. Bowdler, executive officer, Pacific Highway Association, Portland, Ore.; Eugene W. Stern, chief engineer, highways of Manhattan, New York, N. Y.; R. C. Hunt, contractor, Washington Court House, Ohio.

IN California, part of which is semi-arid and part arid, the State Highway Commission has laid many miles of concrete roads 16 and 18 ft. wide and only 4 in. thick, which have given entire satisfaction. In Oregon, chiefly semi-arid, many miles have been built 16 ft. wide with a thickness

of 5½ in. at the sides and 6½ in. at the crown, which competent authority pronounces as being satisfactory. In 1914 3 mi. of 16-ft. roadway were built in which the thickness at the sides was only 4 in. and that at the crown only 5 in., and after 15 months' use this road is in excellent condition. In the Mississippi Valley, the general practice seems to be to make the thickness 6 in. at the side and 7 or 8 in. at the crown. Practice is so variable in the different elements affecting the thickness of the slab, that it is impossible to discover any definite relationship between thickness and width.

The crown used in practice for concrete roads without curbs, varies from 1/24 to 1/200 of the width, without much tendency to group within any smaller limits. For concrete pavements with curbs, the crown employed in practice varies from about 1/50 to 1/150 of the width, the intermediate values being used about equally.

The standard specifications for concrete roads adopted by the 1914 session of this conference call for a crown of 1/100 of the width, and this committee sees no reason to change this recommendation. However, one member of the committee believes that in the Mississippi Valley a crown of 1/150 is not too flat, and another member believes that in a warm and arid region a crown of 1/200 is justifiable.

The surface of concrete roads or pavements is sometimes grooved, scored, or corrugated to make it less slippery; but the practice is believed to be unwise, since the corrugations weaken the slab.

In the arid regions, a few concrete roads have been built with 10 per cent grades, and grades of 5 and 6 per cent are common and entirely satisfactory. In a humid climate, a grade of 5 or 6 per cent is about the limit for a concrete surface finished with a wood float. However, one member of the committee claims that a 7 per cent grade is not slippery in Iowa, and cites the case of a 12 per cent grade on a main street in Platteville, Wis., which teamsters prefer to any other pavement in the town.

Joint Location and Construction

Committee—George A. Ricker, chairman, ex-first deputy commissioner, New York State Highway Commission; H. J. Kuelling, county highway commissioner, Milwaukee, Wis.; Fred C. Smith, consulting engineer, Philip Carey Company, Cincinnati, Ohio; E. D. Boyer, engineer, Atlas Portland Cement Co., New York; Austin W. Summers, contractor, Buffalo, N. Y.

IN the present state of the art of building concrete pavements, joints seem to be necessary and unavoidable. Transverse joints should be located in concrete road pavements not less than 25 ft. nor more than 50 ft. apart. Under favorable conditions, particularly where reinforced with embedded metal, longer sections of pavement have been successfully used. In suburban single-track pavements joints should not be placed more than 33 ft. apart; for double-track roads, 50 ft. apart.

Results of practice seem to indicate that structural stability of road concrete is secured when the slab in length is approximately three times its width. Where concrete is laid 50 ft. or more in width, as street pavement in villages or cities, transverse joints not more than 25 ft. apart are recommended.

Transverse joints should be not less than $\frac{1}{4}$ in. nor more than $\frac{3}{8}$ in. in width and should be placed across the pavement at right angles to the center line. Where curbs are used, a longitudinal joint not less than $\frac{1}{4}$ in. wide should be placed between the curb and the pavement. All joints should extend through the entire thickness of the pavement, and it is most important that they be constructed in a plane perpendicular to the surface in order to prevent lifting or slipping of one side or the other, especially on grades.

Careful spading of the mixture, in placing, next to the joints is urged, and the use of a suitably designed edging tool is recommended. Protection of transverse joints in concrete by the use of metal plates is not recommended. The committee recognizes that the practice regarding protection of joints is not uniform and competent engineers and road builders differ upon the question of the necessity for the use of metal plates.

A suitable pre-formed joint filler should be used and should be made of some plastic material that will remain soft in cold weather and will not run in warm weather.

Expansion and Contraction

Committee—F. E. Turneure, chairman, college of engineering, University of Wisconsin; Paul D. Sargent, chief engineer, State Highway Commission, Augusta, Me.; Gaylord C. Cummin, city manager, Jackson, Mich.; W. A. McIntyre, chief road engineer, Association of American Portland Cement Manufacturers.

THE following conclusions may reasonably be drawn:

Contraction and expansion are caused both by temperature changes and by changes in moisture conditions, and that under climatic conditions similar to those at Washington, D. C., the effects from these two factors in concrete road surfaces are approximately of the same magnitude.

In concrete roads, contraction and expansion are sufficient to cause frequent transverse cracks unless joints are provided.

The actual movement in any particular case depends upon the character of the concrete and of the subgrade. A sloppy concrete shows greater movement than a concrete mixed only moderately wet. No more water should be used than necessary to permit of convenient placing and forming.

Shoulders and Curbs

Committee—A. N. Johnson, chairman, until recently highway engineer, Bureau of Municipal Research, New York; A. W. Dean, chief engineer, Massachusetts Highway Commission; A. B. Fletcher, highway engineer, California Highway Commission; Charles E. Russell, county superintendent of highways, Lake County, Waukegan, Ill.; Edward M. Laing, president, Edward M. Laing Company, contractors, Highland Park, Ill.

WHERE traffic conditions are such as to make it expedient to build one-track roads only, not exceeding 10 ft. wide, shoulders 4 ft. wide should be constructed of gravel or macadam, where these materials can be obtained cheaply. Where a two-track concrete road has been constructed, that is, one not less than 16 ft. wide, it will not be necessary to provide shoulders for traffic

purposes, but rather for occasional turning out. In this case the shoulders may be constructed of earth materials, excluding all vegetable or other matter likely to decay. The slope of the shoulders to the gutter should be continuous. Deep open ditches should not be constructed. The slope of the shoulders for 2 or 3 ft. out from the concrete should be but slightly greater than that of the concrete, and then should increase gradually as the gutter is approached.

It is recommended that where practicable the shoulders be sown with grass and thereafter kept mowed. This will effectually protect them from any cross wash and add much to the roadside appearance. The shoulder slopes and the gutter slopes should be made gradual so that a mowing machine may be utilized to cut the grass.

Where the grade of a one-track road is 5 per cent or more the expense of maintaining macadam shoulders is found to be the greatest maintenance expense. The construction which the committee recommends is practically to do away with the shoulders and gutters, and increase the width of the concrete to 15 or 16 ft., and to use curbs, allowing the water in excessive rainfalls to use the entire road as a gutter. Under favorable conditions the cost of constructing the extra 6 ft. of concrete and curbs would not be more than 25 per cent greater than the other method. The cost of maintenance is greatly reduced. Experience has shown that the maintenance of macadam shoulders and gutters on grades constructed in connection with a concrete road has been excessive.

The width of concrete for a two-track road should be not less than 16 ft. and preferably 18 ft. In cuts an arrangement similar to that described for single-track roads for cuts on steep grades is to be recommended, that is, doing away with gutters and shoulders entirely, supplying a curb and allowing the whole road surface to take extra storm water.

The construction here recommended, to do away with shoulders and gutters on heavy grades in cuts and allow the whole roadway to take care of the storm water, suggests a type of construction to be used on hills where the remainder of the road may be of macadam or gravel, but where this form of construction on the hill would have excessive cost of maintenance and comparative high first cost in construction as well.

Finishing and Curing

Committee—Charles Whiting Baker, chairman, editor Engineering News, New York; W. A. McLean, engineer of highways, Department of Public Works of Ontario, Toronto, Ont.; H. M. Sharp, deputy state highway commissioner, State Highway Department, Columbus, Ohio; William M. Kinney, inspecting engineer, Universal Portland Cement Company, Chicago; Howard W. Underwood, Field, Barker & Underwood, Philadelphia, Pa.

CONCRETE roads should be brought to shape with a strikeboard resting upon the side forms and moved forward with a combined forward and side motion like a saw. This motion fills all pockets with concrete and does not have the tendency to pull out the coarse aggregate as a straight forward motion would. Except near joints the striking off is usually done in the direction in which the work is progressing. When the strikeboard approaches to within

about 1 ft. of a joint, it is lifted, placed alongside of the joint and then worked away from the joint. This avoids the danger of piling up material around the joint, or pushing the joint out of place.

Wooden side forms should be shod with 2-in. steel angles secured to the top side of the forms. This not only makes the strikeboard work easier but insures a true road surface of proper thickness. Where a considerable amount of street paving 20 ft. and more wide is to be laid, a strikeboard which can roll on the curbs is preferable.

The pavement is best finished with a wooden hand float, the finisher working from a bridge. The steel trowel tends to slipperiness, and while good results are not impossible with a long-handled wood float, it invites careless finishing, and good work is not generally done with this tool. Early floating or floating immediately behind the strikeboard is to be condemned. Any saving which the contractor may make by this means is at the expense of the wearing qualities and appearance of the pavement.

During hot and windy weather it will usually be found necessary to cover the surface of the finished pavement with canvas as soon after floating as possible, and to keep this canvas sprinkled for several hours. This will help to prevent the formation of shrinkage cracks. When the concrete has had sufficient time to harden the canvas should be removed and the pavement covered with earth or other water-retaining material. This covering should be at least 2 in. thick and should be kept thoroughly wet for a period of from ten to fourteen days. Another method of curing which has been used successfully and at a cost considerably less than that of earth covering and sprinkling, is that known as "ponding." The pavement is flooded so that the water stands about 2 in. deep over the crown of the pavement at the shallowest point.

During warm weather the pavement should be kept closed to traffic for at least fourteen days and preferably for three weeks after construction has been finished.

Cost of Construction

Committee—C. J. Bennett, chairman, state highway commissioner of Connecticut; H. Eltinge Breed, first deputy commissioner, New York State Highway Commission; E. J. Mehren, editor, Engineering Record, New York; C. U. Boley, city engineer, Sheboygan, Wis.; Frank A. Windes, Windes & Marsh, Winnetka, Ill.

THE committee on cost of construction has divided its report into two parts: First, cost data on certain road jobs; second, proposed headings for a uniform cost-reporting system for the construction of concrete roads.

There was such disparity in methods of reporting that comparisons were impossible; in other words, there were few, if any, sets of figures that included the same cost items under the same heads. Extended comparison of costs and conclusions as to percentages chargeable to various features are therefore impossible. There is presented in the latter part of the report a uniform cost-reporting system.

The Association of American Portland Cement Manufacturers has furnished summaries of figures gathered by its concrete road inspection forces during the season of

TABLE 1—AVERAGE COST PER SQUARE YARD OF CONSTRUCTING CONCRETE ROADS, REPORTED TO THE ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS, 1913 AND 1915

Figures for 1915 Gathered by Association's Inspectors

	1913	1915
Connecticut	\$1.32	\$1.13
Illinois	1.01	1.03
Indiana	1.23	0.98
Iowa	1.11	1.19
Kansas	1.08	1.23
Maryland	1.21	1.08
Massachusetts	1.29	0.95
Michigan	1.27	1.10
Minnesota	1.05	1.11
Missouri	1.17	1.09
New Jersey	1.12	1.23
New York	1.22	0.98
Ohio	1.16	1.02
Pennsylvania	1.16	1.01
Texas	1.15	1.15
West Virginia	1.32	1.03
Wisconsin	1.06	1.02

1914. Unfortunately, they are on a square-yard basis. Since the pavement thickness was not shown, the cubic-yard price could not be derived. In order to compare the data, however, with state averages collected by the same association and presented by the committee on cost of construction to the First National Conference on Concrete Road Building, Table 1 is given. It shows in parallel columns the average cost of construction per square yard in various states in 1913 and 1915. These figures, like those of the other tables, are for the concrete pavement only; that is, they do not include charges for grading, drainage, or the other incidental work.

Methods and Cost of Maintenance

Committee—A. H. Hinkle, chairman, deputy highway commissioner, Ohio State Highway Department; L. C. Herrick, county engineer, Huron County, Norwalk, Ohio; John W. Mueller, civil engineer, New Castle, Ind.; Maurice Hoeffken, Hoeffken Bros. Supply & Construction Company, contractors, Belleville, Ill.

JOINTS and cracks can be successfully treated by thoroughly cleaning them and filling them when dry, and preferably during warm weather, with hot tar, then covering with dry sand or screenings. The tar should be permitted to lap over the spalled edges of the crack, but not to exceed 1 in. The most desirable covering is clean, coarse sand or clean screenings of stone, slag or gravel, that will pass a 1/2-in. circular opening, and be retained on a 3/16-in. mesh screen.

The use of a mastic consisting of a mixture of hot tar and sand, in place of pure tar, for filling the cracks and joints, gives promise of excellent results; but perhaps it is too soon to give definite specifications for this mixture. The filling of the larger and more open cracks or joints with the mastic, and the use of the pure tar for filling the minor openings in the pavement and such as are made necessary by settlement after the joints have been originally filled with the mastic, may be found to be most satisfactory.

Small holes and shallow depressions can be successfully treated as follows: Clean surface thoroughly. Where the surface is disintegrated it should first be thoroughly swept with a steel broom; afterward, the dust must be removed by sweeping with a rattan or house broom. The hot tar is then applied to the dry concrete and rubbed well with a squeegee or stiff broom to secure a good bond to the surface of the concrete. The tar is then covered with coarse sand or screenings (1/2 to 3/16 in.) of stone, slag or gravel.

The amount of tar to be used will vary from 1/2 to 1 gal. per square yard, depending upon the depth of the depression to be filled. Where more than 1/2 gal. per square yard is used, it should be applied in two coats and the excess screenings swept off before the second coat is applied. The more tar that is applied to the surface, the more desirable it is to have the coarser material for a covering. In filling small holes the application of the tar in two layers would, of course, be unnecessary.

To repair larger holes and deeper depressions than those just discussed, thoroughly clean and paint the surface with tar. Fill the hole or depression with broken stone, preferably of such size that they will not exceed in diameter one-half the depth of the depression to be filled nor exceed in size stone suitable for an ordinary tar macadam. The stone should be levelled off and compacted as well as may be by tamping or rolling so as to conform to the true surface of the road. The voids are then filled with the hot tar and screenings applied to the surface, which is again compacted and treated as in building a tar macadam by the penetration method.

The use of a cold mix consisting of clean, hard stone chips coated with a coal tar cut-back, for filling such holes and depressions, as described under the above paragraph, has been followed to some extent with very

concrete conforming in quality as nearly as possible to the concrete of the surrounding pavement. The new concrete should be kept well dampened for about seven days.

The use of a tar top over the entire surface to protect and maintain a good concrete road is not necessary and of doubtful economy. It may be desirable and economical to maintain such a top on a concrete road not made of first-class concrete. While such a tar top has in the majority of cases proved a failure, many instances exist where it has stuck well, which seems to indicate that if the right grade of material is applied to a suitable surface in the proper way, good results will be secured.

Reasonably accurate cost data for maintenance have not been kept over long enough periods to predict the average maintenance cost of the concrete roads until they are worn out. The best available data seem to indicate, as a conservative estimate for roads that have been down from one to five years, a maintenance cost of less than 1/2 cent per square yard per year.

Wing-Wall Weir Stops Erosion

SOIL EROSION was stopped and a gully spractically reclaimed on a ranch on Rose Road, near Pasadena, Cal., by means of a weir between the outer ends of extra-high



WING-WALL WEIR FORMS NON-ERODING STILLING POOL

promising results. The stone chips are first thoroughly coated with the coal tar preparation by turning with shovels after the tar has been sprayed upon them, as in mixing ordinary cement concrete. The mixture is then permitted to stand a few days until the lighter oils vaporize from the tar, which leaves the stone coated with the heavy tar. The coated chips are then well tamped into the hole or depression to be filled, the shallower depressions being first painted with the pure tar. Coarse sand or fine screenings are then spread over the surface. If the voids appear quite open after the coated chips have been thoroughly tamped, a light application of the tar is made to seal up the voids before the surface screenings are applied.

Where the pavement is disintegrated badly or broken clear through so as to require rebuilding, it should be cut away with vertical edges and replaced with new

wing walls. The velocity of approach has been checked sufficiently to build up the eroded portion from the settled material in an impounded pool nearly to the top of the weir crest. The fruit crates in front of the weir indicate the fertility and high value of the land being reclaimed.

TYPHOID-FEVER CASES IN CHICAGO during 1915 numbered 915, as against 1181 for 1914. This is the lowest number of cases reported in nine years, according to the annual report of Dr. J. D. Robertson, commissioner of health. The 133 deaths give a rate of 55 per cent below the average for the last decade. Typhoid vaccination of the survivors of the Eastland disaster who were immersed in water at a point where a sewer entered the Chicago River prevented any cases from developing. Only one survivor contracted the disease, and she refused the treatment.

Literature

For the Civil Engineer and Contractor

New Publications

FARM DRAINAGE IN NORTH CAROLINA. By H. M. Lynde, senior drainage engineer, U. S. Department of Agriculture. Bulletin 234, North Carolina Agricultural Experiment Station. Paper, 6 x 9 in.; 31 pages; illustrated. Raleigh, Va., State Department of Agriculture.

LEGAL RIGHTS OF CIVIL SERVANTS in the City of New York. Bulletin 66, Bureau of Municipal Research. Paper, 6 x 9 in.; 202 pages. New York, Bureau of Municipal Research, 261 Broadway. \$1.

IRRIGATION PRACTICE AND ENGINEERING VOL. 3—Irrigation Structures and Distribution Systems. By B. A. Eicheverry, head of the Department of Irrigation, University of California. Cloth, 6 x 9 in.; 438 pages; illustrated. New York, McGraw-Hill Book Company, Inc. \$4 net.

SUMMARY OF RAILWAY RETURNS for the year ending June 30, 1915. Consecutive No. 88, Miscellaneous Series 22, Bureau of Railway Economics. Paper, 6 x 9 in.; 23 pages. Washington, D. C., Bureau of Railway Economics.

This is the first of a series of proposed annual publications which aims to present as soon as possible after the close of the fiscal year the significant statistics of the more important railway systems, compiled from their annual reports to the Interstate Commerce Commission.

TWENTY-FIRST ANNUAL REPORT OF THE BOSTON TRANSIT COMMISSION, 1915. Cloth, 6 x 9 in.; 102 pages; illustrated. Boston, Boston Transit Commission.

THIRTY-SIXTH ANNUAL REPORT OF THE DIRECTOR OF THE U. S. GEOLOGICAL SURVEY, 1915. Paper, 6 x 9 in.; 186 pages; illustrated. Washington, Government Printing Office.

WATER RESOURCES OF HAWAII, 1913. By C. K. Larison. Water-Supply Paper 373, U. S. Geological Survey. Paper, 6 x 9 in.; 190 pages. Washington, Government Printing Office.

THE OPERATION AND CARE OF SEWAGE DISPOSAL PLANTS. By D. C. Faber, industrial engineer. Bulletin 16, Engineering Extension, Department Technical Service, Iowa State College. Paper, 6 x 9 in.; 23 pages; illustrated. Ames, Iowa, Iowa State College of Agriculture and Mechanic Arts.

STREAM POLLUTION AND SEWAGE DISPOSAL IN ILLINOIS with Reference to Public Policy and Legislation. By LeRoy K. Sherman, C. E. Bulletin 16, Rivers and Lakes Commission, State of Illinois. Paper, 6 x 9 in.; 32 pages. Chicago, Rivers and Lakes Commission of Illinois, Charles Christman, Secretary.

WATER SUPPLIES OF KANSAS, PART 1—Ground Water Supplies. By C. A. Haskins, associate professor of civil engineering, engineer, State Board of Health, and C. C. Young, director, water and sewage laboratory, State Board of Health. Bulletin 10, University of Kansas. Paper, 5½ x 8½ in.; 187 pages; illustrated. Lawrence, Kan., University Engineering Experiment Station.

COMPREHENSIVE PLAN OF NEWARK. By the City Plan Commission of Newark, N. J. Paper, 6 x 9 in.; 180 pages; illustrated. Newark, N. J. The City Plan Commission.

LIVE LOAD STRESSES IN RAILWAY BRIDGES with Formulas and Tables. By George E. Beggs, A. B., C. E., assistant professor of civil engineering in Princeton University. Cloth, 6 x 9 in.; 123 pages; illustrated. New York, John Wiley & Sons, Inc. \$2 net.

DAMS AND WEIRS. An Analytical and Practical Treatise on Gravity Dams and Weirs, Arch and Buttress Dams, Submerged Weirs and Barrages. By W. A. Bligh, inspecting engineer of irrigation works, Department of Interior, Canada. Cloth, 5½ x 8½ in.; 206 pages; illustrated. Chicago, American Technical Society.

POLE AND TOWER LINES FOR ELECTRIC POWER TRANSMISSION. By R. D. Coombs, C. E., consulting engineer. Cloth, 6 x 9 in.; 272 pages; illustrated. New York, McGraw-Hill Book Company, Inc. \$2.50 net.

MANUFACTURE AND USES OF ALLOY STEELS. By Henry D. Hibbard. Bulletin 100, U. S. Bureau of Mines. Paper, 6 x 9 in.; 77 pages. Washington, Government Printing Office.

REPORT OF BOARD OF ENGINEERS ON FLOOD CONTROL to the Board of Supervisors of Los Angeles County, California. Paper, 8 x 11 in.; 400 pages; illustrated.

Copies of this report may be obtained by addressing the Board of Supervisors of Los Angeles County, Los Angeles, Cal.

THE DISPOSAL OF HUMAN EXCRETA AND SEWAGE OF THE COUNTRY HOME. By Theodore Horton, director, Division of Sanitary Engineering, New York State Department of Health. Paper, 5½ x 8½ in.; 18 pages; illustrated. Albany, N. Y., Division of Publicity and Public Health, New York State Department of Health.

FINAL REPORT OF THE CONSTRUCTION OF THE TUMALO IRRIGATION PROJECT to the Desert Land Board, State of Oregon. By O. Laurgaard, project engineer. Paper, 6 x 9 in.; 90 pages; illustrated. Laidlaw, Oregon, Desert Land Board, State of Oregon.

CO-OPERATIVE CENTRALIZED PURCHASING IN THE CITY OF NEW YORK. Results of a year's practical test of central purchasing in the Mayor's departments, conducted by the Mayor's Central Purchasing Committee, 1915. Paper, 6½ x 10 in.; 49 pages; illustrated. New York City, Mayor's Central Purchasing Committee.

ANNUAL REPORT OF THE LIBRARY BOARD, UNITED ENGINEERING SOCIETY, 1915. Paper, 8 x 10 in.; 28 pages; illustrated. New York City, United Engineering Society.

PROCEEDINGS OF THE TWENTY-THIRD ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, 1915. Cloth, 6 x 9 in.; 374 pages; illustrated. Pittsburgh, Pa., Secretary, F. L. Bishop, University of Pittsburgh.

Books Reviewed

Applied Mechanics

Author, Ewart S. Andrews, B. Sc. Eng. (London), lecturer in the Engineering Department of the Goldsmith's College, New Cross, and of the Westminster Technical Institute. Cloth, 6 x 9 in.; 316 pages; 184 illustrations. Cambridge, England, Cambridge University Press; New York, G. P. Putnam's Sons. \$1.10.

This book discusses the basic principles of mechanics in the most elementary form with the idea that too much attention is usually paid to mathematical treatment of the subject and not enough to the driving home of the important fundamentals.

There are seventeen chapters discussing the usual subjects, under the following heads: Statics, Dynamics, Kinematics, Strength of Materials, and Mechanisms. The arrangement is not logical and the treatment is very superficial.

As a text book for engineering students it is far too elementary, and it would be of little use as a reference book.

Kidder's Architects' and Builders' Pocket Book

Author, the late Frank E. Kidder; compiled by a staff of specialists; Thomas Nolan, professor of architectural construction, University of Pennsylvania, editor-in-chief. Sixteenth edition, rewritten. Flexible leather, 4½ x 7 in.; 1816 pages; illustrated. New York, John Wiley & Sons, Inc. \$5 net.

In the seven years which have elapsed since the previous edition of Kidder's well-known pocket book for architects and builders was issued, in 1908, many new developments in the field of building construction have taken place. The new sixteenth edition has therefore been entirely rewritten and reset by Professor Nolan and an able corps of thirteen associate editors, of whom nine are engineers. The fact that so many engineers are the authors of much of the matter on materials of construction and on strength and stability of structures will insure an even wider field of usefulness among structural designers than the older editions enjoyed.

The original arrangement in three main divisions has been retained: Part 1 on practical arithmetic, geometry and trigonometry; Part 2 on materials of construction, and strength and stability of structures, and Part 3 giving miscellaneous useful information. Part 1 has been checked and rearranged, the twenty-eight chapters of Part 2 have been entirely rewritten and one new chapter on reinforced-concrete mill and factory construction has been added by the associate editors, each chapter being

signed by its author. Part 3 has been largely rewritten, and new matter has been added in the form of tables.

As an indication of the scope of the matter in Part 2, which is given in most satisfying form, the following more important chapters, with the names of the authors, can be mentioned: Foundations, by Daniel E. Moran, consulting engineer, of New York City; Masonry Walls, Footings, Cement and Concrete, Strength of Brick, Stone, Mass Concrete and Masonry, by Professor Nolan, editor-in-chief; Forces and Moments, Types of Roof Trusses and Stresses in Roof Trusses, by M. A. Howe, professor of civil engineering, Rose Polytechnic Institute; Stability of Masonry Arches, by G. T. Snelling, architect; Reactions and Bending Moments for Beams, Properties of Structural Shapes, Strength of Columns, Posts, Struts, Beams, Girders, Stiffness and Deflection of Beams, Continuous Beams and Riveted Girders, by Charles P. Warren, assistant professor of architecture, Columbia University; Resistance to Tension, Properties of Iron and Steel, Resistance to Shear, and Bearing Plates, by H. C. Berry, professor of materials of construction, University of Pennsylvania; Fireproofing of Buildings and Reinforced-Concrete Construction, by Rudolf P. Miller, former superintendent of buildings, New York City, and Reinforced-Concrete Factory and Mill Construction, by E. G. Perrot, of Ballinger & Perot, architects and engineers, Philadelphia.

Some of the values for unit stresses allowable in timber have been reduced to conform to more conservative practice, and the tables and examples revised accordingly. Additional notes or new matter explain the derivation of many formulas more fully, and practical problems with their solution have been added. The tables giving the properties of structural shapes and safe allowable loads on beams and columns for usual unit stresses used in practice are very complete and useful.

The text is reset in much improved form, so that it can be read more easily. Each paragraph has a black-face caption, greatly facilitating use of the book for reference, and many cross references are added for the same purpose. In its new form the book should prove most helpful to all engineers whose work is along lines of building construction.

Problems Pertaining to Steel Tubes

Author, O. G. Welton, M. E., formerly lecturer and assistant professor of mechanical engineering in the School of Mining, Queens University, Canada. Cloth, 5 x 7 in.; 172 pages; 34 illustrations and diagrams. New York, D. Van Nostrand Company. \$2.50 net.

REVIEWED BY A. G. HILLBERG

Civil and Hydraulic Engineer, New York City.

Steel tubes of circular cross-section have found a variety of uses in modern engineering, but little is known about the stresses such tubes are called upon to withstand. Special cases have been treated scientifically, but the assumptions constituting the foundation on which the theories have been constructed limit the application of the formulas.

In dealing with the subject the author has endeavored to establish formulas of such form that they can be applied to a number of practical cases. He has also considered the question of the frictional resistance to sliding, a factor that seemingly has been neglected. The book requires a thorough knowledge of higher mathematics.

The present volume, which is apparently the first of a series, deals with circular tubes resting in a trough. The maximum errors due to approximations are discussed, and the deformations of the shell under different conditions considered, with the conclusion that, "In order to support a tube so that the vertical and horizontal deflections are equal and of the same size, the points of support should be two and located from 90 to 118 deg. apart."

The second chapter treats of lined tubes, as the first is applicable only to very thin tubes. In designing a lined tube it is necessary to add the values found in corresponding equations of these chapters, while in chapter 3 these two separate problems have been discussed as one, and in addition it has been assumed that the tube carries a liquid under pressure. The author presents a number of new facts in respect to the distribution of tension and compression and has clearly shown the location of the plane of greatest stress.

At the end of the volume the author compares the greatest stress in a tube, when supported on two points spaced 90 deg. apart and when supported on a horizontal surface, and finds that in the latter case the stress is 230 per cent greater than in the former. The book is well written and the mathematical treatment of the subject excellent.

The Ohio Water Problem

Author, C. E. Sherman, professor of civil engineering, Ohio State University. Bulletin 15, College of Engineering. Paper, 6 x 9 in.; 135 pages; illustrated. Columbus, Ohio State University.

REVIEWED BY MORRIS KNOWLES
Consulting Engineer, Pittsburgh.

In "The Ohio Water Problem" the author presents a plea for a far-sighted policy of stream regulation in Ohio—for a program that not only will aim at the negative good to be derived from guarding against flood damage, but also and to an even greater extent will strive to attain the positive benefits that will accrue from comprehensive stream regulation in the years intervening between floods.

A novel and interesting method has been used in making this plea to the people of Ohio in that it is presented not as propaganda by argument, but rather as a treatise instructing the reader first in the general principles of stream regulation, and finally giving him a telling object lesson taken from an important Ohio problem of to-day, from all of which the reader himself can draw the obvious inference.

After devoting several chapters to floods and plans for flood protection, in which it is wisely concluded that each and every stream presents a highly individual problem which no general prescription is at all likely to fit, the author passes to a consideration of the other advantages to be gained from stream regulation. A wealth of figures and facts are presented to prove the relative economic value of water transportation upon canalized rivers, as compared with artificial canals. In a chapter devoted to the relation of the federal government to stream regulation and to the necessity for a wise and comprehensive plan for the ultimate development of each stream, the author takes occasion to illustrate some of the evils arising from the existing policy (or lack of policy) in haphazard legislation based on local selfishness and pork barrel politics. Concerning water power, it is concluded that the opportunities for develop-

ment in Ohio are few, though well worth while in the exceptional instances in which they relate to large-scale projects. Other and subsidiary benefits of stream regulation accruing to agriculture, public and industrial water supplies, sanitary drainage and pleasure are briefly reviewed.

There follows the proposal of a remarkable plan for the canalization of the Scioto and Sandusky rivers, and the diversion in this manner of a portion of this Ohio River flood drainage into the Lake Erie drainage. According to the author, this plan would effectually secure not only the prevention of floods, but also the benefits of water transportation, water power, water supply and subsidiary uses, all of which is strongly contrasted, from the standpoint of both cost and benefits, with past and present "piecemeal" plans for flood protection alone, thus strikingly illustrating the advantage of comprehensiveness in planning for stream control. Whether the proposed plan would

accomplish all that the author claims could be determined only by a study far more extensive than a review of this interesting paper. But this question is of relatively small importance, since the illustration is carried far enough to demonstrate that this plan, or another resembling it in comprehensiveness, may be made entirely practical and economical. The book closes with thirteen appendices containing many interesting and valuable data on the waters of Ohio.

In the past Ohio, in company with most other states, has been backward in giving thought to its water problem and in attacking that problem in a scientific manner. Even the recent flood-control legislation in that state, admirable as it is in many respects, cannot be considered a final step in this direction. Professor Sherman's work is therefore timely, and it is to be hoped that so able a presentation of his plea will not go unanswered by Ohio's legislators.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Data Sought on Brick Faces for Concrete Bridge Piers

SIR: The writer is interested to know if any one has used brick for an outside face for concrete bridge piers so as to make the brick serve the purpose of a form for the concrete. The idea would be to lay a sufficient proportion of brick "header" fashion to make bond with the concrete filling, the face course of brick being only 4 in. thick except for occasional headers.

If so, has it proved satisfactory in use, that is, in service? And how many days should the brick shell set before filling with concrete? And about what would be the limiting amount of concrete that could be placed at a run before the shell would be damaged by pressure from the fresh-mixed concrete, assuming a rather wet mix? Some cost data also would be interesting.

GEORGE C. LOVE,
Civil Engineer.

Pineola, N. C.

Why Is Registration in Civil Engineering Decreasing?

SIR: Replying to your request for an expression of my views on the decrease in registration of engineering students at our colleges, indicated by the article on page 766 of your issue of Dec. 18, 1915, I am glad to do so briefly.

I do not think that such a decrease is an unfavorable symptom, but, on the contrary, I think it quite the reverse, provided the decrease does not take place in too large proportion from the class of young men who could best profit from the instruction—or, in other words, provided the standard of ability of the students is maintained. I am convinced, by many years of teaching and practice, that a large proportion—very likely more than one-half—of the students in our colleges and engineering schools do not gain from their courses enough to pay them for taking them. This, of course, may not be due to the colleges, although they have serious faults, but is primarily due to

the students themselves, and to the fact that the collegiate standard of accuracy, of thoroughness, of achievement, is lower than that of the commercial and business world.

In other words, a man can go through almost any college with a standard which in business would cost him his job; and no academic degree has much value, because it does not guarantee any good quality. The constitution of the American Society of Civil Engineers is perfectly right in its admission requirements, in making an engineering degree the equivalent of only two years of actual practice. In my opinion, therefore, it would be a benefit, both to the community and to the students themselves, if a large proportion of those who go or are sent to college were set to work in business and obliged to earn their own living instead. This is especially true of the sons of rich men.

My observation has convinced me that the average college graduate knows nothing accurately or thoroughly, cannot think logically or observe correctly, has not gained habits of accuracy, and does not know how to obey orders. He has a half knowledge of many interesting facts, but he does not see them in the right proportion, or know how to use them. Not infrequently, too, a college or engineering education educates nearly all the common sense out of a man. Consequently, when he goes to work he has to learn all over again, besides unlearning a good deal, and he has to experience some hard knocks before he can be of much use. Probably the greatest benefit which most men derive from college comes from the acquaintances which they form, and the discipline they get from athletics, but these are possible of attainment in other ways.

These statements may be considered exaggerated, but they are deliberate, and based upon experience. Many teachers are apt to think that, because they are teaching a thing, the students are learning it. They do not distinguish between getting a thing into the curriculum and getting it into the student. Those who have really investigated the matter, however, know that the

young men who go to work instead of going to college, and who take correspondence courses, or night courses, attending such schools as the Pratt Institute, the Mechanics Institute, Cooper Union, Franklin Union, the Wentworth Institute, and the Lowell School for Industrial Foremen, acquire more real knowledge than the average college graduate, and without the conceit and unwarranted self-assurance that the latter so often possesses in marked degree.

Let it be understood that this is not a criticism of our colleges and engineering schools. They offer great opportunities for those who are able to take advantage of them. But, unfortunately, higher education, like the symphony concert, has become fashionable, instead of being reserved for the comparatively few. In some of our colleges, the failure of a student is looked upon by some of the faculty, or even by the authorities, as the fault of the teacher. Every effort is made to increase the number of students, more importance being placed upon quantity than upon quality. As a consequence, our colleges and engineering schools are turning out large numbers of routine, rule-of-thumb men.

In my opinion, we need *more moral training, and more discipline of the entire body of boys and girls, and less higher education.*

GEO. F. SWAIN,

Professor of Civil Engineering, Harvard University and Massachusetts Institute of Technology.
Cambridge, Mass.

What Is an Engineer?

SIR: A most important step forward in the investigation of the necessary requirements of engineering education has been taken by the Carnegie Foundation, working in co-operation with the Committee on Engineering Education of the American Society of Civil Engineers, as noted in detail in the Engineering Record of Jan. 22, page 125. The investigation to date, based on replies to a circular letter received from 1500 practising engineers, discloses the fact that these latter believe that the qualifications of an engineer are 13 per cent technical and 87 per cent human.

We all like to believe this, but the question arises, whether these are the proportions which should apply to the student just graduating from a technical school or college? Should not the qualifications of such a young man be just about reversed; that is, 87 per cent technical and 13 per cent human? Can a young graduate have understanding of men, executive ability, efficiency, judgment, perspective, responsibility, resourcefulness, initiative, etc.? I think not. These can only be attained and obtained by practice and experience, and are the attributes only of the engineer who has had practice and experience.

The student, and especially the senior, should have the necessity of acquiring all these attributes fully impressed upon him, and he should know not only that they must be acquired if he is to become really and truly an engineer, but also how, in a general way, he may best acquire them.

Before sending out the further inquiry, which it is understood is to be made before the Foundation finally decides this important question, it would be well to consider the advisability and necessity of differentiating between the requisite attainments of the student who at graduation is just begin-

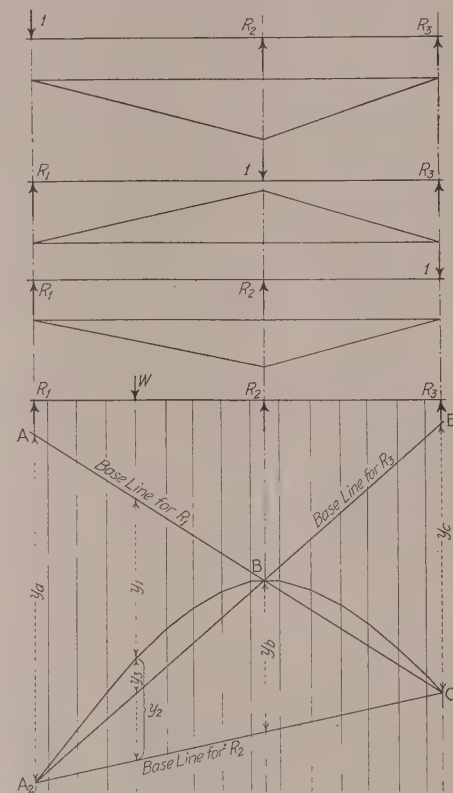
ning his career as an engineer, and the necessary qualifications of the engineer "who is competent to design as well as direct engineering work."

ENGINEER.

Elastic Curves and Influence Lines

SIR:—In your issue of Dec. 18, 1915, I read with interest the article on page 762 by your associate editor, J. P. J. Williams, containing a treatment of statically indeterminate girders by influence lines. I arrived at practically the same graphical constructions about two years ago, while figuring shafts for machinery. To the excellent treatment given by Mr. Williams I may add the following:

The influence line for the reaction R_1 of a continuous girder of two spans was given



INFLUENCE LINE FOR ALL REACTIONS GIVEN BY ELASTIC CURVE

in the above-mentioned article by an elastic curve obtained by considering a load unity applied at the support R_1 while the support is supposed to be removed. The accompanying figure shows this influence line, and also illustrates the fact that, by changing the base from which ordinates are measured, the influence lines for reactions R_2 and R_3 are easily obtained.

In the figure I have drawn the base lines A_1C and A_2E for the reactions R_2 and R_3 . For any given load W the reactions would then be:

$$R_1 = Wy_1/y_0 \quad R_2 = Wy_2/y_0 \quad R_3 = Wy_3/y_0$$

The principle upon which this construction is based becomes evident by considering the fact that no matter at which support a load unity is applied, considering that support removed, the shape of the bending-moment diagram is always a triangle with its vertex at the middle support, as indicated in the figure. The scale of the bending-moment triangles is immaterial for the purpose of the constructions in question, since it enters as a factor both in the

numerator and denominator of the expressions for the reactions and eventually vanishes.

For the case shown y_3 is negative, and therefore R_3 is negative. As a check:

$$R_1 + R_2 + R_3 = W, \text{ or } \frac{y_1}{y_0} + \frac{y_2}{y_0} + \frac{y_3}{y_0} = 1$$

In case of many loads, it is well to apply this check to the construction and test this remarkable property of the curve before using it. The above principle can be utilized for finding reactions for girders of more than two spans.

I. DUBERSTEIN, C.E.,

Public Service Commission of the First District.

New York City.

Decimals of the Degree and of the Full Circle

SIR: I wish to reply to the comment of C. L. Berger & Sons on my letter on the subject of providing one vernier of the transit to read the decimal divisions of degrees, which letter was published in Engineering Record of Jan. 22, page 121.

The only objection to the unlike verniers seems to arise from the desire to check angular measurements by reading both verniers. The custom of taking simultaneous readings on the two verniers is in vogue or a very small proportion of transit work. Ask a dealer about his single-vernier instrument. When both verniers are used there are two possible advantages, catching up errors in readings and eliminating errors due to irregularity in the graduations of the transit limb. The latter possibility may be ignored entirely if all transits are as trustworthy as are the Berger and other good instruments that I have had the pleasure of using. And on ordinary work errors in the readings are as unlikely to occur when full attention is given to one vernier as when the two verniers are read and both speed and accuracy are desired.

While the vernier reading to hundredths of degrees is an extremely simple matter, it has very probably been overlooked by the great majority of transmitters. And engineers would not likely think to ask for this contrivance when purchasing a new instrument. My contention in this respect is that manufacturers could make more favorable the chances of a change from minutes to decimals if they would give a choice of verniers with new instruments and would offer to supply decimal verniers for old ones, calling attention to these facts in their catalogues.

LEONARD C. JORDAN,

Heffley School of Civil Engineering,
Brooklyn, N. Y.

UNRELIABILITY OF SAMPLE TESTS OF CONCRETE, found by tests made of 6-in. cubes cast on the work at the Twenty-ninth Street Pier, Brooklyn, has led the Department of Docks and Ferries of New York City to the decision to test floor slabs themselves in the future by applying a load equivalent to twice the live load for which the slab was designed. As given in the November *Bulletin of Tests* of the Bureau of Standards, Supply Division, Board of Estimate of New York City, the sample cubes showed great variations in compressive strength at 30 to 37 days—from 1220 to 3020 lb. per square inch. Eleven of the twenty-four specimens were below 2000 lb. and averaged only 1545 lb. per square inch.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.—EDITOR.]

Concrete Tower Erected Within Armory Drill Hall

SO LARGE is the Second Infantry Armory of the National Guard in Chicago that a concrete tower was erected under the steel arches. From it the concrete was conveyed in chutes hung from the arches to a discharge hopper over the balcony forms. Runways were provided over the forms to the point of deposit. The building has

the large three-hinge arches by a double-boom steel traveler. The arches which carry the concrete balcony have a span of 198 ft. and a rise of 89 ft. measured between the pins. They are spaced 37 ft. apart and are connected by deep latticed struts on which are carried the curved purlins supporting the roof. The arches were assembled on the ground and completely riveted to make two complete segments, each about 120 ft. long. They were erected by a steel traveler 38 ft. square and 38 ft. high, on which was mounted two 90-ft. booms. The heels of the segments were first lifted into the cast supporting shoes and the heel pins driven. Each boom was then attached to a segment near the crown pin and

the surface of the concrete, or slightly below it. The men operating the strike board were instructed not to work closer to the joint than 2 ft., but to be sure to leave the concrete around the joint a little high. The clamps holding the several parts of the joint together were left in place for more than half an hour. The finishers were then required to wade in the unsurfaced strip of concrete next the joint, and, by the use of a 3-ft. straightedge, cut the concrete down to the level of the finished pavement adjoining, using the top of the steel joint as a template to support one end of the straightedge. In this way no abrupt changes in level were possible at the joints, and the concrete was made to meet exactly the top of the steel.

Gasoline Locomotives Safe in Tunnel Work if Properly Run

GASOLINE locomotives used in mine and tunnel work may develop a quantity of carbon monoxide as great as 5% per cent of the piston displacement, which makes them dangerous to health if operated in headings where a good ventilating system is lacking. This occurs, according to O. P. Hood and R. H. Kudlitch, who have just completed a careful series of experiments announced in Bulletin 74 of the Bureau of Mines, only when the locomotive is running at full speed and full load on an excess of gasoline. The maximum efficiency for the weight of gasoline consumed, and also the least amount of carbon monoxide, was reached when the locomotives tested were running at 85 per cent of capacity on a mixture just rich enough to avoid backfiring. Consequently it appears that if locomotives of excess capacity be operated so as to obtain the greatest fuel economy, there is no danger, in using them in tunnel headings, from the highly poisonous gas, carbon monoxide. The quantity of this gas given off under these conditions amounts to one-third of 1 per cent of the piston displacement. To reach this condition for any given load and position of throttle the operator should close the needle valve until occasional backfiring occurs and then open it just enough to prevent further backfiring. If a first-class ventilating system exists there is little danger from carbon monoxide poisoning in any case, but the locomotives should be operated in the manner outlined because of other considerations. When running as described the cylinders stay cleaner. When the cylinders become coated with carbon it interferes with the cooling system, causes trouble with the spark plugs, and induces overheating. This in turn results in disagreeable "smoke" from burning lubricating oil. In addition to fuel economy the life of the locomotive is increased by careful operation.

According to these men, American gasoline locomotives are not entirely safe in headings where gas or dust is present in sufficient quantities to form an explosive mixture with the tunnel air. American manufacturers have not yet appreciated the demand for a locomotive that is entirely proof against the emission of flames from



SPOUTING PLANT INSIDE ARMORY WAS SUPPLIED BY MOTOR TRUCKS AND RUN AS IF IN OPEN

a front 236 ft. long on West Madison Street and extends through to Monroe Street, a distance of 266 ft. The West Madison frontage is three stories and basement, with a large central tower five stories high and a rear arched drill hall 200 ft. wide, 126 ft. long and 90 ft. high. The building is of fire-resistant construction throughout, with reinforced-concrete foundation, basement walls and floors, including a balcony which extends around three sides of the drill hall.

All of the concrete was furnished by two portable 1/3-yd. Standard mixers to which materials were delivered by motor trucks around the building and inside the drill hall near the point of deposition. Much of the concrete was spouted directly into the forms. In the drill hall the mixers were picked up and moved about bodily several times by the travelers erecting the steel work.

Another feature of interest in the construction of the armory was the erection of

the two segments lifted simultaneously by rocking them back on the heel pins until the crown pin holes registered, permitting the crown pin to be driven. By this method the booms were required to lift only about one-fourth of the weight of the arch, the total weight of which was about 36 tons.

The armory was designed by James B. Dibelka, state architect. The general contractor was the C. E. Carson Company, for which the Morava Construction Company, as sub-contractor, erected the steel work.

Concrete Pavement Struck Crosswise at Steel Expansion Joints

IN BUILDING a concrete road at Tonawanda, N. Y., some of the construction methods on which were described on page 171 of the Engineering Record for Feb. 5, a novel method was used to bring the Baker steel expansion joints at the exact level of

the muffler or carbureter, and against sparking outside the cylinders. Such locomotives, having closed ignition circuits and other devices, are in use in Europe, and are considered perfectly safe under any conditions in which men are able to work.

Gasoline for locomotive use should not be stored underground in pump chambers or other places where the ventilation is poor. These experiments show, however, that where there is a good current of air the gasoline, even if spilled in quantities, will not evaporate fast enough to produce an explosive mixture.

Improved Blow Torch Heats Concrete Inside the Mixer

AN IMPROVED kerosene glow torch with its flame directed into the mixer barrel employed for heating the concrete aggregates on New York subway work during cold weather was described by Robert Ridgway, engineer of subway construction for the Public Service Commission, in a paper read before the twelfth annual convention at Chicago (Feb. 14-17) of the American Concrete Institute. The paper quoted a report by Andrew Veitch, assistant division engineer of the commission, on this device.

The U. S. Realty & Improvement Company and the Rapid Transit Subway Construction Company, contractors on Seventh Avenue for routes 4 and 38, sections 5 and 6, are using, as described in this report, an attachment placed on the mixer which forces a flame or hot blast directly into the mixer, thus raising the concrete to the desired temperature while it is being made. Almost any degree of heat may be obtained by leaving the materials in the mixer different lengths of time. If the heat tends to dry out the mix, sufficient water may be added to maintain the right consistency for use.

The apparatus itself consists of the ordinary kerosene blow torch inserted in a large pipe placed at the hopper through which the heat is forced and directed into the mixer. A 30-gal. kerosene tank is placed on top of the mixer, from which the oil feeds into the burner. Here it is vaporized and burns, the flame being forced into the mixer by a blast of compressed air. This air is supplied by a direct connection to the contractors' air lines feeding the rock drills. It is evident that in using this method the contractors are able to make a considerable labor saving in eliminating rehandling of the materials to heat them. Also it is possible to save much space formerly required on the street for this purpose, as with this arrangement materials can be mixed and placed as fast as they are delivered from the docks or store yards.

Heavy Concrete Footings Suspended in Underpinning Columns

A CONCRETE mat footing 6 ft. thick supporting four heavy columns, the total load being about 900 tons, was hung one side at a time on suspender rods from the main needles in underpinning the Seventh Avenue side of the steel and brick building at Fourteenth Street and Seventh Avenue, New York City. This was found cheaper than removing the old concrete footing and underpinning the columns di-

rectly. On account of subway construction along Seventh Avenue, it was necessary to carry the foundations of this twelve-story building to rock. The bottom of these foundations along Seventh Avenue was from 12 to 15 ft. above the subgrade of the new subway and consisted of spread concrete footings and I-beam grillages resting on sand and gravel, just a few feet above the ground water level. On account of the comparatively small depth to which these footings were carried, about 12 ft. below curb level, it was necessary to underpin both westerly lines of columns along Seventh Avenue.

In underpinning the northwest corner of the building, the most interesting section of the work, as the other columns rested on much smaller footings, the two north col-

the 30-in. needles, and by carrying the middle of each beam in a saddle which transferred the load by two 3-in. diameter rods to the short 24-in. beams. Thus the entire load on the columns and the weight of half of the mat was transferred to the main needlebeams.

The excavation under one-half of this mat was next made to about four feet above the subgrade of the subway excavation, wood and steel sheeting being used. Five 16-in. steel pipes were then driven under each column to rock, about 16 ft. below subgrade, and excavated with post-hole augers. These pipes and the excavation above were then filled with concrete up to within 3 ft. of the bottom of the concrete mat. Two granite wedging stones were then placed to transfer the load to the new foundation.



NORTH EDGE OF OLD CONCRETE MAT AND NORTH COLUMNS SUSPENDED ON NEEDLEBEAMS
Sheeting around top of pit dug to reach bottom of mat shows at lower left-hand corner.

umns along Fourteenth Street were first needled. Brackets, riveted to the columns, transferred the load to 24-in. 140-lb. I-beams, which in turn rested on the main needlebeams running parallel to Seventh Avenue. Four of these latter, which were 30-in. 180-lb. I-beams, were required per column. The south ends had a bearing on the south end of the concrete mat, and the north ends were set on timber cribwork. Not only did these beams carry the weight on the columns, but they also held the dead load of half of the concrete mat, which it was decided not to remove. As soon as the load on the columns was transferred to the beams, by the usual method of jacking, 3-in. sheet piling was driven around the corner column and the one next to it on the Fourteenth Street side and the excavation carried to the bottom of the mat. Seven short 9-in. I-beams, 6 ft. long, were then placed under the mat at three different points, with one end of each butting against the sheet piling, the other ends catching under the mat with a bearing of about 2 ft. These 9-in. I-beams were then made into inverted cantilevers by running posts up from the ends nearest sheet piling to the bottom of

Thus the north end of the mat rested on a new concrete footing, which at the east and west ends was carried on pile clusters.

The southern half of the concrete mat was underpinned next by sliding the main needlebeams south, with their north ends bearing on the new foundation and their south ends on the footings of the next two columns southward. The new concrete footing was placed as on the north end, except that three additional piles were driven between the columns. The work was then continued from north to south in the same manner until all the columns in the two rows on the Seventh Avenue side had been underpinned.

The work at this point is part of section 4, routes 4 and 38, of the Seventh Avenue-Lexington Avenue subway. F. W. Carpenter is division engineer and J. F. Fouhy section engineer for the Public Service Commission, of which Robert Ridgway is engineer of subway construction. For the contractors, the Engineering and Construction Department of the United States Realty & Improvement Company, C. H. Stengel is chief engineer and E. A. Little general superintendent.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Concrete Institute Makes Sand Leading Topic of Convention

Necessity of Long-Time Mixing and Detailed Attention to Sand with Modulus of Fineness Defined Features of Program

Moving pictures indicating the necessity of long-time mixing of concrete and better handling methods made the Wednesday evening meeting of the nine-session convention of the American Concrete Institute in Chicago, Feb. 14 to 17, the best attended. The topic of sand analyses, sand specifications, sand quality and sand in relation to other aggregates was discussed as never before by the institute. As more than forty papers and eleven reports were presented, many of them being read in full, the interest lagged considerably at times, although the average attendance at each session was about fifty. The final registration was 435.

Pavement Specification Changes

The report of the committee on concrete roads and pavements, presented by A. N. Johnson, chairman, had been awaited with such interest that the hall was crowded to hear of the changes. Only four alterations in last year's proposed specifications were made: First, provision is made for a field test of the fine aggregate. Second, mixing in the drum is to be continued for a full minute, irrespective of the size of batch and rate of speed used, although that rate must be not less than 12 r.p.m. Third, reinforcement shall have a weight not less than 28 lb. per 100 sq. ft. Fourth, an additional specification has been prepared for concrete pavement between street-car tracks whereby the traffic is to be excluded for two weeks. A motion to adopt the specification was carried unanimously after Mr. Johnson stated that no changes had been made without definite evidence before the committee.

Long-Time Mixes Already Used

Nathan C. Johnson told the convention that there is a growing tendency to insist upon longer mixing periods for concrete.

His moving pictures indicated the speed with which many mixers have been working and later he showed views indicating the change during a year's time, even in general advertising, from the idea, "speed of mix" to "quality of mix."

In constructing the tall, hemispherical-bottom water tower at Middleboro, Mass. (see page 279), George Sampson, consulting engineer, stated in his paper on the subject that the concrete was retained in the mixer for 1½ min. for the foundation concrete and 2 min. for the tank and tower concrete.

John T. Gephart, in constructing the Easton-Allentown concrete road in Pennsylvania, insisted on concrete being mixed for 1½ min., according to a paper presented on the subject. He added that tests indicated that the additional time was well spent.

S. F. Butler, in reviewing a paper on the DuPont Boulevard, by Charles Upham, chief engineer (see page 280), stated that the test indicated long-time mixing.

H. S. Scoyoc, chief engineer of the Toronto-Hamilton Highway Commission, described, by the aid of moving pictures, a 36-mile stretch of Canadian concrete road now in the course of construction. This highway is said to be the longest concrete road of its width. Of special interest was the operation of two mixers, side by side, on a 50-ft. pavement and

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Concrete Road Conference Evokes Large Volume of Practical Information

Largely Attended Sessions in Chicago Consider Details Summarized in Seventeen Committee Reports—Code of Practice Adopted

CONFIDENCE in concrete roads was the most marked characteristic of the second National Conference on Concrete Road Building, held in Chicago Feb. 15 to Feb. 18. While many men at the first conference, held in the winter of 1914, had not then been convinced of the value of this comparatively new type of highway, this attitude of doubt was conspicuously absent at last week's meeting. It was evident from the discussions in the conference, and from the corridor talk, that the art was more in a formative stage two years ago, but that now the principal problems had been solved. For that reason there was little debate on the more important questions. Refinement and details received the more attention. The sentiment in favor of the highest class of workmanship was very apparent, as was also a clear appreciation of the necessity for efficient maintenance. Of the particular technical features the most noticeable, probably, was the sentiment in favor of increasing the distance between expansion joints.

At its final session the conference adopted a resolution authorizing the continuance of the advisory committee and investing the latter with full power to arrange for another conference, to set the date and make any changes in its organization it deemed necessary. The conclusions of the conference are published on page 275, and the committee reports on page 286.

The total registration at the conference was 698, with an average attendance at sessions of about 400. Dr. W. F. M. Goss, chairman of the conference, presided at the first and last sessions. The other meetings were presided over by Dean F. E. Turneaure, of the college of engineering, University of Wisconsin; Richard L. Humphrey, Philadelphia; Hector J. Hughes, professor of civil engineering, Harvard University; H. E. Breed, first deputy commissioner, New York State Highway Commission.

General Papers

The plan of the convention was to take up the details of concrete road construction with the committee reports, of which there were seventeen, as the basis. The first session, however, was given up to general papers. W. G. Edens, president of the Illinois Highway Improvement Association, and Henry B. Joy, president of the Lincoln Highway, discussed the general problems of road improvement, pointing out that appreciation by the general public is necessary in order that the highway movement may continue to grow.

Major Amos A. Fries, Corps of Engineers, U. S. A., discussed the value of permanent highways for national defense and brought out considerable discussion. There was keen interest among the highway engineers present as to the strength of bridges needed to provide for the passage of an army. Major Fries assured those present that bridges that will carry a 16-ton tractor will provide adequately for army needs. He laid very great stress on the need for an adequate number of well-trained men, saying that highways for defense, forts, warships and all other military equipment are useless without an adequate army to man and operate them.

Edward Hoopes, of the Fidelity & Deposit Company of Maryland, discussed maintenance funds for concrete roads, taking the position that five-year maintenance clauses, not only on concrete roads but on all types, should be abolished. He maintained, and in this he was heartily supported by those who participated in the discussion, that experimentation should not be made at the expense of the contractor or through the agency of maintenance funds, but should be assumed by the municipality or state on their own initiative. He did advo-

Military Map Data Collected Quickly by Approximate Methods

Exigencies of War Demand Speed Rather Than Extreme Accuracy, According to Capt.

Richard T. Coiner, Corps of Engineers, United States Army

While the basic principles of map-making for military purposes are the same as those for topographic surveying in civil practice, the soldier's work is radically different in its objects, methods of procedure and apparatus employed. These differences were explained by Capt. Richard T. Coiner, Corps of Engineers, U. S. Army, in the second military lecture of the series organized by the four national engineering societies and delivered Feb. 21 in the auditorium of the Engineering Societies Building, New York City. As a supplement to Captain Coiner's address, Capt. Halstead Dorey, aide-de-camp to General Leonard Wood, outlined the object of the military training camps held last summer at Plattsburg, N. Y., and to be repeated this year.

Immense Battlefronts Now

The fact that battlefronts have increased from a length of a few miles during the Civil War to hundreds of miles in the present war in Europe was cited by Captain Coiner as evidence of the tremendously increased importance of military maps. A commanding officer, to-day, cannot hope to see all of his troops in action. He must remain at some central point and base the plans for his campaign upon reports from his subordinates. In this work maps are of the utmost value, and it is the duty of engineer troops to supply them regularly each night as a guide for the next morning's orders governing troop movements.

While existing maps, such as those furnished by the United States Geological Survey, are of considerable value, they do not give all information of a military nature which is desired. A military map, Captain Coiner pointed out, should show the character of all roads, with the existing grades, especially the steepest; all trails; railroads, with the number of tracks, siding, stations, cuts and fills, etc.; telegraph and telephone lines; lakes; canals with locations of locks and dams; streams, with the width, depth, strength and direction of current and character of banks; fords and ferries, and bridges, with the type and ma-

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cate, however, a one-year maintenance fund, feeling that this was a sufficient guarantee that the work had been properly performed. Sentiment in the conference, if those who spoke were representative, was clearly in favor of the abolition of the maintenance fund.

Among the other miscellaneous addresses was one on "Motor Haulage and Good Roads," by S. M. Williams, of the Garford Motor Truck Company. He pointed out that the truck manufacturers, and also the builders of pleasure automobiles, are vitally interested in the good road problem, for their equipment is almost useless if roads are impassable. This is especially true of motor trucking, and he cited many instances where trucks could not be used at all because of road conditions. He explained in detail the character of the highway campaign that has been conducted by his company. A booklet has been distributed among highway improvement associations, sent to individuals in counties where bond issues were to be voted on, supplied to universities which requested them, and in general furnished to anybody who could make use of them in connection with highway campaign work.

Subgrade and Design

In discussing the report on "Organization of Concreting Crew," presented by H. P. Gillette, editor of *Engineering and Contracting*, H. J. Kuelling, of Milwaukee, advanced an objection to advertising work early in the winter. While this method was satisfactory, he stated, for local contractors, those from other sections could see so little in the winter months that there was no advantage. Discussing the matter of force account versus contract work, Charles Whiting Baker, editor of *Engineering News*, maintained that force account was just as satisfactory as contract work, provided a competent engineer who knew construction methods was employed and provided also his hands were not tied by political considerations. As opposed to Mr. Baker's view, another speaker called attention to the fact that governments and municipalities, as a rule, do not keep their forces from one year to another, taking chances upon being able to pick them up again in the spring. The good contractor, however, keeps a nucleus of his best men from season to season.

Under the head of width of pavement there was a spirited discussion as to the advisability of building single-track roads as narrow as 8 or 9 ft. In general the sentiment was in favor of a 10-ft. width, but instances were cited where the narrower pavements had given satisfaction. W. M. Acheson, of the New York State Highway Department, cited a case of a 6-mile road only 8 ft. wide, in which the pavement was placed to one side of the center line, so as to carry the loaded traffic. The light traffic took the earth or macadam road alongside. If this design proves satisfactory, he stated, more mileage of that type would be built. The advantage of placing the road to one side is that if later the traffic gets to be very heavy, the other portion can be paved, making a 16 or 18-ft. roadway.

Under the heading of design, objection was made to brooming the surface. George A. Ricker, consulting engineer, Albany, N. Y., and formerly first deputy commissioner of the New York Highway Department, pointed out that brooming helped the situation with the horse and the farmer at the start. The horses have a rougher pavement and become used to it by the time it wears smooth. There is further advantage in the fact that during curing the corrugations hold the moisture. Automobilists, of course, do not like the broomed pavement, because it is hard on the tires. The brooming is therefore done lightly.

Aggregates and Mixing

The discussion of the report of the committee on aggregates, which was presented by D. A. Abrams of the materials research laboratory, Lewis Institute, Chicago, showed that there was a remarkable interest even in so

technical a subject as this. Between 350 and 400 men stayed through a long, and sometimes tedious, discussion, showing that there was keen appreciation of the importance of the subject and a sincere desire to learn. Among the important points brought out in this discussion was Rudolph J. Wig's statement that an exhaustive study of test results obtained during the last ten years shows that the sand should be tested with the aggregate with which it is to be used in practice. Tests of the sand separately are unsatisfactory because the samples, giving the highest results may give the lowest when combined with the coarser material.

The report of the committee on reinforcement aroused a great deal of discussion. The committee had recommended that all concrete roads be reinforced. It was very apparent, however, that those present did not indorse this point of view. On going into the details of the discussion it became apparent that the reinforcement could not be considered as assisting in carrying loads, but was used merely to spread the cracks and keep them small. The experience of those, however, who have laid both reinforced and unreinforced roads was to the effect that the maintenance cost on the reinforced roads was considerably lower than upon the plain roads. A number of speakers stated that they believed it merely a matter of cost, saying that analysis should be made to see whether the cost of reinforcing might not be saved, and whether an amount equivalent to or less than the interest charge on the saved amount would not maintain satisfactorily an unreinforced road.

Chute Distribution Indorsed

The committee on mixing and placing concrete, whose chairman was Ernest McCullough, of Chicago, reported at length the results of tests made by the committee upon a chute type of concrete mixer. Despite conclusions reached and published two years ago condemning the chute type of machine, this committee found that the chute was as satisfactory as the boom-and-bucket type. The committee also made tests of the effect of hydrated lime upon the material. While it did not find that the concrete with the addition of hydrate flowed more readily, as has been claimed, the committee found that there was a distinct advantage in preventing segregation. It was noted, too, that the water was quickly squeezed out of samples using hydrated lime, and in which an excess amount of water had been used in order to secure good flow in the chutes. The committee strongly recommended the weighing type for measuring water, which has been introduced recently on a new mixer.

Joints and Maintenance

After the presentation of the report of the committee on joints, vigorous discussion indicated that the tendency is to increase the distance between them. Some even advocated the entire omission of the joints, in these cases using a reinforced-concrete pavement. In general, too, those who favor a considerable spacing distance, prefer to reinforce their slabs.

Much interest was displayed in the report of the committee on maintenance, and a spirited discussion ensued. It was apparent that there is now keen appreciation of the need for close attention to incipient holes and to cracks as soon as they appear. The chairman of the committee, A. H. Hinkle, deputy highway commissioner of Ohio, showed by lantern slides the maintenance outfits used in various states. He also gave cost of maintenance on roads in Ohio. The brick and concrete roads last year averaged \$29 per mile. Other types ran up into the hundreds. Mr. Hinkle placed strong emphasis on the need of segregating the cost of maintaining the surface from the other maintenance items, such as the expenditures on ditches, brush cutting, guard rails, etc. After the presentation of his paper he called attention to the danger of placing too much tar on cracks and in holes, thus, by successive applications, building up a mound around the depression which will eventually result in shat-

tering the pavement as vehicles drop from the mound onto the concrete. It was suggested that it might be possible to scrape off this excess tar before a re-application. Mr. Hinkle pointed out, however, that this was difficult and that the very best method was to exercise care in placing the material in the first instance.

Recommended Practice

At the final session the conference adopted, after an intelligent discussion in which good points were made, the report of the resolutions committee. This carried with it a code of recommended practice, summarizing the main points agreed upon by the conference. The code will be found on page 275 of this issue.

The resolutions also expressed the appreciation of the conference to the Cement Products Exhibition Company, which financed the meeting.

Concrete Institute Makes Sand Leading Topic of Convention

(Continued from page 295, column 1.)

their subsequent finishing from a special I-beam bridge.

Sand Modulus of Fineness Defined

Add up the percentages of sand passing six sand sieves ranging from 4 to 100 meshes per inch and the sum is the arbitrary modulus of fineness of sand, described by Duff A. Abrams in his paper on "Tests of 885 Sand Samples at the Structural Materials Research Laboratory at Lewis Institute." Numerous other tests have been made during the past four years on these sands to determine their efficiency for making concrete. Both briquettes and compression cylinders were made. These relations were plotted by Mr. Abrams with the idea that so great a number would eliminate the effect of freak sands and give general laws. In general, a high modulus, meaning a fine sand, gives a low strength. A modulus of 325 corresponds approximately to a standard sand mixture.

C. C. Brown, in a paper on "How Shall a Rational Specification for Gravel Concrete Be Developed?" outlined the problems in Indiana and detailed an ambitious program proposed at Purdue University for testing all the gravels of the state to determine the line of demarcation between sand and gravel.

Cloyd M. Chapman illustrated the use of the Universal sand tests and stated that tests could be made in the field in 10 min. time and that the results checks closely with dry-sieve methods.

The committee on concrete aggregate, of which Sanford E. Thompson is chairman, presented a progress report only. Some striking reductions in strength of specimens stored in the dry, as compared with those stored in damp sand, were outlined.

E. J. Moore, chairman of the committee on reinforced concrete and building laws, presented a suggestion for the anchorage of stirrups to the slab which was criticised by Prof. A. N. Talbot as not having a sufficiently good connection with the steel in the top of the beam and in the slab. The report was received, but as there were numerous objections the specifications were held in abeyance with the suggestion that as many clauses as possible be made to conform to those issued by the Joint Committee.

A cement drain-tile specification was submitted by R. F. Havlik, chairman of the committee on building blocks and cement products. It was accepted, but cannot be adopted until another year, as the rules require submission at least thirty days prior to the convention.

The committee on nomenclature, F. C. Wight chairman, was instructed to get in touch with a proposed joint committee of other organizations. No changes were made in the definitions presented last year.

C. B. McCullough's report of the committee on reinforced-concrete highway bridges and

With the Equipment Manufacturers at the Cement Show



1, Cement Companies' Exhibit. 2, Koehring mixer. 3, Knickerbocker mixer. 4, Chain Belt paving mixer. 5, Insley tower and chute. 6, Waterloo mixer. 7, Ideal mixer. 8, Hains gravity mixer. 9, Milwaukee paving mixer. 10, Foote paving mixer. 11, Municipal mixer. 12, Jaeger concrete machinery. 13, Gemco form braces. 14, Smith-Chicago paver. 15, Hydraulic pressed steel forms.

culverts was received as information. It contained valuable data on the preliminary investigation, selection of type, loading and determination of the design of highway spans. A plea was made for more definiteness in the outside investigations.

In view of the recent interest in patent litigation, Prof. W. K. Hatt's paper on "Genesis of Reinforced Concrete Construction," going back sixty-four years, and A. E. Lindau's paper on "Construction of Flat-Slab Floors" will be of particular value to engineers.

The board of direction announced at the final session that H. D. Hynds, 30 Broadway, New York, had been elected secretary. Other officials were announced in the News of Engineering Societies column on page 266 of last week's issue.

Chicago Cement Show Most Elaborate Ever Held

Coliseum Not Affording Sufficient Space, First Regiment Armory is Also Used—Exhibits Indicate Tendency Toward Sturdier Plant and Equipment to Meet New Conditions

IF the amount of space needed to accommodate the exhibits is an index of the interest in concrete the Ninth Annual Cement Show held in Chicago last week was a mark of great progress. Space demands exceeded the accommodations of the Coliseum, and about 40 per cent additional room was secured by using the First Regiment Armory, nearby. Of radical departures there were few, though the whole line of exhibits again displayed the tendency shown in recent years to build sturdier plant and to meet the new conditions which engineering investigation has imposed on construction equipment. For example, to secure more desirable slopes on chute types of paving mixers there were two high-drum machines shown, while a water-measuring device on the weight, instead of the volume, principle was exhibited. There was comparatively large participation, too, of manufacturers of what might be termed auxiliary equipment, in the sense that its use is not confined to concrete jobs. Such, for example, were the motor trucks, pumps and hoists. Mixer exhibits led the list in numbers. The show, as usual, was well arranged, skillfully managed, and staged in a very satisfactory decorative style.

Cement Companies' Exhibit

By far the largest space allotted to any exhibitor was that of the cement companies, which had all pooled their interests in an effort to present material of high educational value. Chief among the items in the large space occupied in the Armory was a testing demonstration, which compared the results of, say, 1:6 mix with graded and with bank-run materials. Comparative cylinders had been made up in advance and were tested at advertised periods each day. The results chalked up on a blackboard showed strikingly the inferiority of the bank-run specimens. Crowds gathered always during the demonstrations, and even during periods between the tests interested and intelligent groups gathered in the booth to quiz the demonstrator in charge.

Near by were other features that preached silently but eloquently the danger of bank-run mixes. Side by side were the ingredients of batch mixes of the same nominal proportions—one set of separated, the other of bank-run aggregates.

Other features in the cement companies' exhibit were pavement slabs showing methods of tarring cracks and incipient holes, and panels showing the artistic possibilities of various methods of finishing concrete surfaces. Colored aggregates in some of the panels gave very striking effects.

With the Mixer Manufacturers

A new grouting outfit and a complete mixing and spouting plant were shown by the Jaeger Machine Company, of Columbus, Ohio. A feature of the grouting outfit was a grout cart equipped with plows so mounted on the axles as to revolve in the grout as the cart is wheeled from the mixer, thus keeping the

grout agitated and preventing segregation. It is said that a Jaeger Big-an-Little mixer with special grouting equipment and the Turner grout cart described, form a highly economical outfit for grouting brick pavements. The Jaeger spouting plant shown included a mixer and an inclined track from mixer to center of form. The concrete is discharged from the mixer to a skip car, carried to the top of the track and here discharged into double-jointed spouts which can be made to reach all points on the form.

A new 10-ft.-capacity paving mixer, referred to as the Lincoln Highway type, was featured in the space of the American Cement Machine Company, Inc., Keokuk, Iowa. Features of this machine include all-steel construction and Hyatt roller bearings, the latter materially cutting down power consumption and lubricating cost. Other new models of this company's line on view were a 10-ft. low-charging mixer; a "Boss" mixer, of the same capacity, with power loader; and a 5-ft. Packard mixer.

New types of drum machines in 5 and 10-ft. sizes, batch or side loader, occupied the booth of the Northwestern Steel & Iron Works, Eau Claire, Wis. Chilled-steel roller track, dust-proof bearing boxes and other new features met with favorable comment.

In addition to a Hains mixer the Automatic Concrete Mixer Company, Providence, R. I., exhibited a controllable discharge bottom-dump bucket which the company is now marketing in sizes from 1 to 7 cu. yd. Features claimed for these buckets, aside from their great capacity, include means for permitting the contents to be spread out without the need for shovelers and for keeping the bucket stationary while the contents are discharging. It is said that the discharge is so thoroughly controlled that the largest sizes can be used without danger to the lightest forms. Any portion of the load may be dumped at any point. The sloping bottom of the bucket gives the contents another mixing as it is dumped, the principle being the same as that of the Hains mixer. This type of bucket has been used on some large jobs.

The new 1916 line of drum mixers and pavers put out by the Municipal Engineering & Contracting Company, Chicago, were on exhibition. The low-chargers and side loaders are made in 4½ ft. and 6 ft. wet capacity. The paver is also of 6-ft. capacity. These are low-priced mixers of good appearance and fit in well with the "Cube" line.

Other New Mixer Ideas

In addition to the standard line of pavers and mixers usually shown, the Koehring Machine Company, Milwaukee, Wis., had a new group called the "Dandie." This includes two sizes of small batch mixers and two sizes of high-drum pavers with a chute delivery.

Automatic stops on the charging skip together with reduction in width to a clearance of 87 in. for close quarter operation are the new features on the No. 12 paver found in the booth of the Chain Belt Company, Milwaukee, Wis. The low-charging Rex mixers, 6 and 10-ft. wet capacity were also shown, together with a rack from which hung a complete set of samples of Chabelco all-steel chain belt.

Three sizes of Foote pavers, 27-E, 13-E and 10-E, 2/3 yd., 1/3 yd. and 1/4 yd. respectively, were shown by the Foote Concrete Machinery

Company, Chicago. Three systems of distribution were represented, boom and bucket, chute delivery, and cart-guide and bumper. The new feature of the exhibit was the 1/3-yd. mixer equipped with boom and bucket delivery. This new machine is the latest addition to the Foote line.

A new model low-charging mixer, 7 ft. wet capacity was on exhibit for the first time in the space of the Marsh-Capron Manufacturing Company, Chicago. This mixer is equipped with loading platform and large charging hopper. The paver is now equipped with two speeds forward and reverse, and is ready for delivery in 7, 10, 17 and 27 cu. ft. wet capacity.

Pavers with boom and bucket or chute delivery, side loaders, low-charging Wisconsin mixers, and a working model of a Wylie tower and chute made up the collection of contractors' machinery shown by the Milwaukee Concrete Machinery Company, Milwaukee, Wis. The Wisconsin No. 9 is now equipped with a low-loading platform or side loader.

The new high-drum Smith-Chicago paver was the feature of the T. L. Smith Company's exhibit, which included new models of low-charging and side-loading mixers. The new paver is made in four sizes, equipped with chute delivery with a minimum slope of 20 deg. This outfit was described at length in the Engineering Record last week, page 268. A small model Smith Duo-Cone mixer, a Mixerette and the new Smith-Chicago low charger with 16-in. loading platform completed an interesting exhibit.

The Eureka Machine Company, Lansing, Mich., displayed its new line of batch mixers in addition to its mortar mixers and continuous machines. One of each type of machine included in the company's product was shown as was also a portable contractor's pumping outfit.

The new 8-ft. batch mixer which the Knickerbocker Company, Jackson, Mich., has just placed upon the market was in evidence. The 5 ft. machine was also shown as was one of the road pavers and Coltrin continuous mixers. The new 8 ft. machine has a catch which holds the charging hopper when elevated and thus relieves the brake.

Additional Mixer Exhibits

Among the other mixer exhibits were the following:

W. E. Dunn Manufacturing Company, Holland, Mich.—Small mixers, cement-tile machines, and a semi-Diesel oil engine (new) in 2, 3, 4½ and 6-hp. sizes.

Waterloo Cement Machinery Corporation, Waterloo, Iowa—"Wonder" mixers, of which the 10-ft. paver was new.

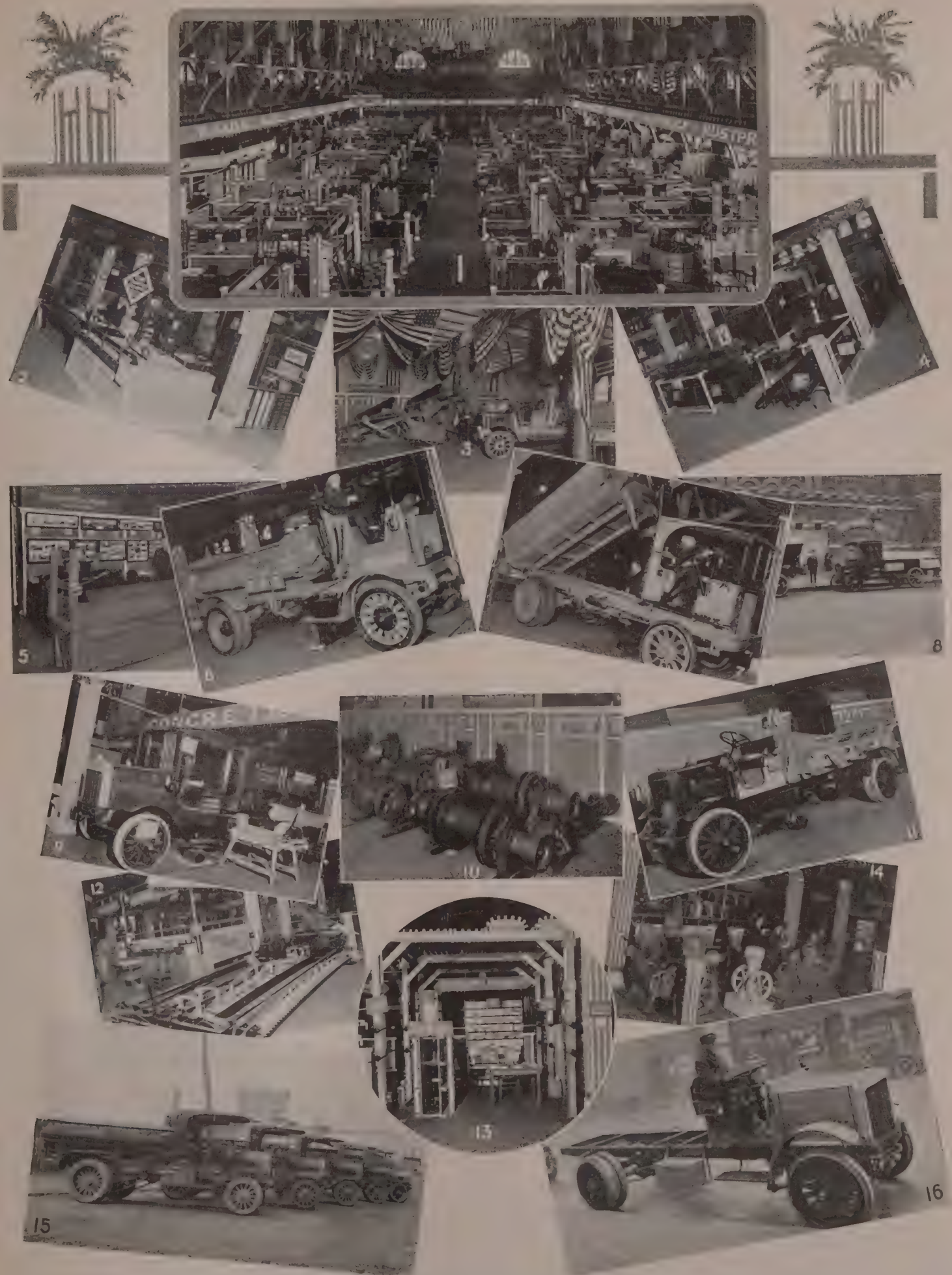
Standard Scale & Supply Company, Chicago—The "low charging line" in ten sizes, from 4 to 40 cu. ft. dry capacity, represented by six models.

Oshkosh Manufacturing Company, Oshkosh, Wis.—Mixers, pavers and low loaders, saw rigs, trench pumps and back-fillers. The back-filler and the low-loading mixers of 5 and 7½-ft. wet capacity are new machines.

Schaefer Manufacturing Company, Berlin, Wis.—A low charger and an improved saw rig with bandsaw and several new attachments.

Atlas Engineering Company, Milwaukee, Wis.—Two models of batch mixers of 5 and 7-ft. dry capacity.

Cement Show Exhibits Covered Wide Range of Products



1. Exhibits in Chicago Coliseum. 2. Trussed Concrete Steel Co. 3. R. W. Dull Co. screen and Federal truck. 4. Blaw forms. 5. Sauerman Bros. 6. Sterling truck. 7. Garford truck. 8. Harvey truck. 9. Gramm truck. 10. Thomas hoists. 11. Service truck. 12. R. D. Baker finishing machine for concrete roads. 13. Keator and American forms. 14. Sultan pumps. 15. Mack trucks. 16. Locomobile truck.

Republic Iron Works, Tecumseh, Mich.—The "Republic Light Ten," a new batch mixer of 10-ft. capacity of dry materials with low charging platform and automatic loader.

Blystone Manufacturing Company, Cambridge Springs, Pa.—Concrete mortar and plaster mixers and demonstrations of the process of concrete block making.

Ideal Concrete Machinery Company, Cincinnati, Ohio.—Batch mixers of sizes up to 14 ft. of loose material, a complete concrete block making plant in operation, and various types of the company's automatic conveyors and feeders.

Kent Machine Company, Kent, Ohio.—A three-hopper portable continuous mixer in operation, with sand-weighing device.

What the Form Makers Were Showing

The Blaw Steel Construction Company, Pittsburgh, found a clear way to show visitors how its products were being used on big work by exhibiting half-size models of the steel forms used in constructing the New York subways, the Wilson Avenue tunnel, Chicago, and the retaining walls on the Chicago, Rock Island & Pacific track elevation, also in Chicago. Two new specialties were exhibited, a full-round telescopic sewer form and an adjustable rectangular culvert mold. The latter provides for the insertion of side plates, so that culverts from 2 ft. high up to any other size can be formed. The office occupied by the Blaw representatives was built entirely of Blaw light-wall forms. A section of the space formed a good-roads exhibit, showing steel forms for curb and gutter, sidewalk and all types of concrete-road construction. Other forms shown included types for sewers, columns and walls. Special steel plates used for lining soft-ground tunnels were also exhibited.

The Hydraulic Pressed Steel Company, of Cleveland, showed a full-size section of the Calumet sewer forms furnished by the company to Byrne Brothers Dredging & Engineering Company, Chicago. Another portion of the exhibit presented a model of a house poured into Hydraulic house forms at Euclid Beach, Cleveland. Also on view were a number of full-size standard Hydraulic wall forms designed to form walls of any desired thickness, height and batter.

The exhibit of Edward O. Keator & Company, Cincinnati, Ohio, consisted of a booth built up with the Hodges adjustable shores as the support and the Hodges adjustable floor forms as the roof. The exhibit told its story in a clear and interesting manner.

An instructive booth consisting of actual beam, column and floor panel forms, supported and held by the Gemco adjustable shores and clamps made by the Gemco Manufacturing Company, Milwaukee, Wis., offered a lesson in economical form erection and support. Continuous demonstration of the application and use of these appliances held an interested group of spectators.

A new form clamp for use with wire, together with adjustable metal forms for round columns made up the exhibit of the American Metal Form Company, Chicago. The wire clamps eliminate the twisting of the wire in tying these forms and may be applied and locked in a "jiffy." They are particularly applicable for straight wall, column forms, etc.

Additional Form Exhibits

Among the other form exhibits were the following:

Schulz & Hodgson, Chicago.—Small models and full-size sections of the Hall interlocking culvert.

Reichert Manufacturing Company, Milwaukee, Wis.—Metal forms for straight wall and circular work were shown.

Security Culvert Company, of Minneapolis, Minn.—Models and a full-sized section of the Security concrete sectional culvert.

Hetzel Steel Form & Iron Company, Warren, Ohio.—A new steel manhole form, a new

style of wall form held together without special c-clamps, and a new car unloader chute.

H. D. Cornelius Company, Indianapolis, Ind.—Curb forms and an adjustable cement step form.

D. & A. Post Mold Company, Three Rivers, Mich.—Concrete fence post molds.

Materials Exhibited

One of the largest single exhibits in the Coliseum was that of the Trussed Concrete Steel Company, Detroit. The display covered every item of the company's wide line, including Kahn pressed steel construction for light fire-proof construction, United steel sash, semi-stock sash, sliding and casement sash, reinforcing steel of all types, Floretype, Kahn trussed bars, rib bars, Hy-Rib and metal lath. An important part of the exhibit was a solid slab depicting what was described as "the permanent concrete road of the future." The concrete was reinforced with Kahn road mesh. Expansion joints were protected by the new Kahn armor plate, a feature of which is a beveled joint which produces a flush surface, protects the edges of the concrete slab against chipping and is firmly anchored in the slab.

A special device was installed by the Standard Paint Company, New York, to impress upon visitors the upward pressure on floors due to static heads of water at various heights. A plunger exactly 1 ft. square was placed in a tank connected by hose to a bucket of water so suspended that it could be raised and lowered to increase or decrease the head. The upward push on the plunger was measured on a heavy spring scale. The object of the exhibit was to show builders that floors are frequently made so thin that no amount of waterproofing can keep them dry. As manufacturers of "Impervite," a waterproofing compound, the Standard Paint Company recognizes the wisdom of carrying on educational work of this character.

L. Sonneborn Sons, Inc., New York, evolved a novel way to demonstrate the effect of treating concrete with "Lapidolith," the company's liquid hardener. An abrasion machine held a treated and an untreated specimen of concrete of equal size with equal pressure against a carborundum disc revolving about a vertical axis at about 50 r.p.m. Worn specimens exhibited were said to show that a 2-in. cube "lapidized" wore 1/32 in. on a side, while the untreated specimen wore 1 1/2 in.

Additional Materials Exhibits

Among the other exhibits of materials were the following:

American Steel & Wire Company, Chicago.—Reinforcing steel mesh in rolls, with large photographs of actual uses.

Universal Concrete Bar Company, Chicago.—Miniature models of concrete roads, curbs and intersections with steel bars and plates for the protection of curbs and joints and steel nosing for stair treads.

Carnegie Steel Company and Illinois Steel Company.—Joint exhibit showing various sizes of twisted squares for reinforcing concrete.

Smooth-On Manufacturing Company, Jersey City.—Iron cements for dust-proofing, waterproofing, oil-proofing compound, and floor hardener.

Philip Carey Company, Cincinnati, Ohio.—"Elastite," for use in expansion joints on concrete construction.

Ceresit Waterproofing Company, Chicago.—Products for the protection and "permanentizing" of concrete and allied materials.

Pioneer Asphalt Company, of Lawrenceville, Ill.—Asphaltic products for waterproofing, paint and road surfaces, expansion joints and sheet waterproofing.

Trucks and Hauling Equipment

The contracting field has proved an interesting one for the Sterling Motor Truck Company, of Milwaukee, and in addition to their 3 1/2, 5

and 7-ton dump trucks, it is now placing on its chassis street flushers and sprinklers, as well as pressure road oilers. The chassis is made in two types with the engine either under the foot board or hood. The latter design shortens the wheel base, making a compact truck with short turning radius.

A 7 1/2-ton Mack truck with Mack power dump body was displayed by the International Motor Company, New York. The company also distributed an interesting pamphlet describing how their 6 1/2-ton Saurer trucks recently solved the problem of transporting loads as high as 13 tons for the Carnegie solar observatory over a hazardous trail up Mount Wilson, Cal., 6000 ft. above sea-level.

A dump wagon with a new closing method, eliminating the use of winding chain and ratchet was shown by the America Dump Wagon Company, Cedar Rapids, Iowa. The pivoted 1 1/2-in. steel carrier rods run the full length under each bottom. A single chain connects a carrier rod with the closing lever and one movement shuts the bottom. A foot trip drops either side independently. Capacity, 2 yd. This wagon was designed by Mr. Murray of Murray Brothers, railroad contractors, Cedar Rapids, Iowa.

Two trucks loaded with cement stationed outside of Coliseum formed the exhibit of the Harvey Motor Truck Co., Harvey, Ill. The larger truck is equipped with a Lee two-way side-dump body.

A massive 6-ton truck of new design was the feature of the exhibit of the Gramm-Bernstein Company, Lima, Ohio. It is especially built for hauling cement, asphalt, stone, sand and gravel. The great steel hopper body is elevated vertically by a hydraulic hoist, instead of being tipped at an angle as is the usual custom. Considerable interest was also evinced in the Gramm transmission which obviates the stripping of gears, because the latter are always in mesh, the shifting being done by large square hardened steel dogs.

A power dump, steel body 5-ton truck, responding readily to the operation of levers, all within easy reach of the driver, and a 2-ton delivery truck were shown by the Garford Motor Truck Company.

A 3 1/2-ton contractor's truck with power dump and steel body was on display at the booth of the Federal Motor Truck Company, Detroit, Mich. This is a worm-drive truck, concerning which cost data figures were given in a series of leaflets.

Additional Transportation Exhibits

Among the other transportation and truck exhibits were the following:

Baker Manufacturing Company, Springfield, Ill.—The Maney four-wheel 1-cu. yd. scraper for earth-moving contractors.

Austin-Western Road Machinery Company, Chicago.—A two-speed forward and reverse gasoline tandem road roller, crushers, wagons, oilers and graders.

Galion Iron & Manufacturing Company, Galion, Ohio.—Working models of the Eclipse unloader, graders, scrapers, road drags and other road machinery.

Equipment of a Miscellaneous Character

The Berg rotary concrete surfacer, a new device exhibited by the Elevator Supply & Repair Company, New York, was shown in operation. The machine is designed to supplant hand rubbing in removing board marks and projections from concrete surfaces. One man with this machine can, it is said, cover 1000 sq. ft. per day. The machine, which weighs about 30 pounds, is slung over the operator's shoulder. A flexible shaft from the electric motor revolves 16 self-sharpening steel cutters at 2500 r.p.m. By substituting a carborundum disc for the steel cutters, it is possible to give concrete surfaces a smooth finish, presenting the appearance of a plastered surface, which can be painted.

Devices for reinforcing steel bending, both power and hand operated made up the exhibit of Kardong Brothers, Minneapolis, Minn. The power bender operated by gas engine or electric motor offers the contractor a machine which, it is claimed, will do four times the work of a hand bender, with attendant decrease in cost. The power machine will handle four $\frac{1}{2}$ -in., three $\frac{3}{4}$ -in., two 1-in. and up to one $1\frac{1}{2}$ -in. square rods.

A new line of gasoline engines for contractors' machinery was represented by five sizes, $1\frac{1}{4}$ to 10 hp., in the space of the Brownwall Engine & Pulley Company, Holland, Mich. The display covered both air and water-cooled horizontal enclosed crank case types with jump-spark ignition.

The application of steam as driving power for two-speed hoists was demonstrated by the Thomas Elevator Company, Chicago, in the new 8 x 10-in. double-drum steam hoist which has been designed for exceptionally heavy duty on dragline or cableway operation. There were also shown an electric-driven hoist and a single-speed builder's hoist.

Pressure, trench and centrifugal pumps, saw rigs, band saws, material elevators and mortar mixers were on exhibit by the C. H. & E. Manufacturing Company, Milwaukee, Wis. One of the most interesting machines was a new design of trench pump, with capacity of 3000 gal. per hour. This is claimed to be the most compact unit on the market, weighing but 475 lb. The engine is direct-connected to a worm-drive which lends itself to the compact design.

The booth of the Whitman A. Company, St. Louis, Mo., was occupied with 1916 models of pressure, trench and centrifugal pumps with saw rigs, hoists and engines. Special stress was laid of the high efficiency of the company's centrifugal pumps.

The Sasgen Derrick Company, of Chicago, showed light hand derricks of almost every conceivable type. A 1-ton power tower-boom, with steel fittings, for use on concrete hoist towers was a new feature. In addition a single shaft change gear winch, 5 to 1 ratio, designed to be mounted on the company's 2-ton derrick was exhibited.

A self-contained portable crushing plant including engine, bins, elevators, 7 x 10-in. jaw crusher and screen, particularly adapted for small jobs and highway work, according to the Smith Engineering Works, Milwaukee, Wis., was shown for the first time. A No. 3 Tel-Smith gyratory crusher for heavy work and larger capacity for both portable or stationary plants was also shown. The gyratory crushers are manufactured in seven sizes.

Road builders who attended the Second National Conference on Concrete Road Building were interested in the exhibit of the R. D. Baker Company, Detroit, Mich. A finishing machine for concrete roads was shown in operation. It stamps the concrete and eliminates screeding by hand.

Towering over all the machinery exhibited at the show was a new 40-ft. steel quick-shift boom gravity plant for concrete distribution shown by the Insley Manufacturing Company, Indianapolis, Ind. The new feature of this outfit consists of pivoting the top dumping guides to the sliding frame which carries the receiving hopper. Consequently, in shifting the point of spill, the top dumping guides go along up and down the tower with the shifting of the hopper. The Insley automatic concrete roller hoist bucket was also shown as was the controllable center dump from bucket and the center dump utility bucket. Concrete chutes of the swivel head and continuous line types of the Insley egg shape cross-section were exhibited. A new section of chute of the vertical drop line was shown having a series of baffle plates to check the fall of the concrete and a controllable line gate.

Additional Miscellaneous Exhibits

Among the additional miscellaneous exhibits were the following:

Universal Crusher Company, Cedar Rapids, Iowa.—Crushing equipment, elevators and bins for highway work.

Alexander Milburn Company, Baltimore.—Three new types of acetylene lamps for contractors, including a 100-rated-candlepower hand lamp burning eight hours per charge.

Crerar Adams & Company, Chicago.—Carbic flare lights, Yale & Towne chain falls, shovels, pumps, rope, waste, belting, Wallace bar benders and a dozen other lines of contractors' equipment.

Raymond W. Dull Company, Chicago.—Equipment for gravel plants, screens and cableway buckets.

Sauerman Brothers, Chicago.—Cableway excavators for use in gravel pits, stripping or levee building.

Mays & Talley Company, Chicago.—Pul-someter pumps and American metal hose.

C. A. Londelius & Sons Company, Chicago.—Portable combination salamander and water heater for use in winter weather.

John F. Byers Machine Company, Ravenna, Ohio.—Hoisting engines, excavators and derricks.

The Conneaut Shovel Company, Conneaut, Ohio.—Demonstration of the strength of shovels.

Ideal Engine Company, Lansing, Mich.—A 4-hp. engine direct-connected to a water pumping outfit and another connected to a 5 x 5 in. bulldozer type pump mounted on trucks; the latter is a special outfit developed for road contractors.

Novo Engine Company, Lansing, Mich.—Hoisting engine, pumping outfit and air compressor.

New-Way Motor Company, Lansing, Mich.—A new high-speed four-cycle engine claimed to be the first high-speed machine put out for general purpose work.

Joint Board Formed to Unify Engineers on Matters of Public Policy

In order to exercise a fitting influence in public affairs of engineering character the Minnesota Joint Engineering Board has been organized. Represented on it are the Minnesota Branch of the American Institute of Electrical Engineers, the Minnesota Section of the American Society of Mechanical Engineers, the Northwestern Association of Members of the American Society of Civil Engineers, the Civil Engineers Society of St. Paul, the Minnesota Society of Surveyors and Engineers and the engineering college of the University of Minnesota.

The plan is the outgrowth of an effort to unify the engineers of the state on matters of public policy and have some agency through which co-operation on such matters could be quickly secured. The constitution calls for one meeting a year. Others may be called as necessary on the motion of constituent bodies.

Board Established to Effect Improvements at La Libertad, Salvador

By a recent executive decree a Board of Sanitation and Adornment has been created for the port of La Libertad, Salvador, to effect, if possible, various improvements, according to the January *Bulletin* of the Pan-American Union. The works to be undertaken include the drainage of swamps in and near the town, a potable water supply, the paving of the city streets and the construction of a pier.

To Hold Snow Removal Conference in New York City

A snow removal conference will be held at the Automobile Club of America, 247 West Fifty-fourth Street, New York City, March 8, under the joint auspices of various divisions of the National Highways Association.

Tunnel Blow-Out Carries Man Safely Through River Bed

Blanket 26 Feet Thick Failed to Confine 5 Pounds Unbalanced Pressure Where Theoretically 18 Feet of Cover Was Enough

A blow-out at the top of the shield in the Manhattan-bound, or north, heading of the Whitehall-Montague Street tunnels occurred at 4.05 p. m. Feb. 19 in New York City, carrying one of the men up through the river bottom alive, and resulting in the death of two others. The shield at the time was about 300 ft. beyond the bulkhead line in the old Montague Street ferry slip, and was some 26 ft. below the bottom. The entire area over the tubes had been dredged out and backfilled with clay weighted down with sand. It was supposed that all the soft harbor mud not removed by the dredging must have been squeezed aside by this fill, whose weight was sufficient to carry it to solid bottom. The top 5 ft. of the face at the shield was fine sand at this point, and the remainder of the face sand, gravel and boulders. The 260th cast-iron ring, counting from the shaft, was about to be placed, as the shield had just been advanced 2 ft. by the jacks. Four men had taken out the top board at the face, which was being held with breasting boards over most of its area, and were raking out the sand to reset the board 2 ft. ahead when the upper part of the face gave way. One of the men succeeded in getting down from the shield, but the other three were carried up through the river bed, only one of them being able to swim to safety on reaching the surface. The unbalanced pressure at the top of the shield amounted to only 5 lb., $24\frac{1}{2}$ lb. being carried at the time. This pressure theoretically required only an 18-ft. blanket for safety, whereas 26 ft. had been provided. Trouble had been experienced with small blows in the tail of the shield, but none of consequence had occurred before on the Brooklyn side of the river at the face. The breasting boards were used primarily to hold the face.

The tunnel heading is 540 ft. long and on a 3 per cent down grade, and as the water could rise only till it sealed the air at the top of the shield, all the men working in the heading except the three at the face were gotten out in safety by the foreman. The heading is still carrying 19 lb. of air. An irregular hole 14 ft. deep and 40 ft. across which was left in the clay and sand blanket is being filled with clay, and it is expected that the heading will be in operation again within a week.

These tunnels are being driven for the Public Service Commission, Alfred Craven, Chief Engineer, Robert Ridgway, engineer of subway construction, George Rice, engineer of the division including the work, and Clifford Holland, engineer in charge of the East River tunnels, by the Flinn-O'Rourke Company, Inc. George H. Flinn is president and Major John F. O'Rourke vice-president and chief engineer of the contracting company, for which Michael J. Quinn is general superintendent, and LeRoy Tallman is in direct charge of the Brooklyn ends of the tunnels.

Board of Engineers Recommends Arches for Galveston Causeway

The board of engineers, composed of one engineer to represent each railroad using the causeway, has just recommended to the railroad managers that the damaged fill approaches of the Galveston causeway be reconstructed by using reinforced-concrete arches. The damage to the causeway was described in the Engineering Record of Aug. 28, 1915, page 272, where drawings showing the original construction and the details of the 70-ft. arches which withstood the flood are shown. The board recommends that there shall be used for the new approaches twenty-eight 70-ft. arch spans similar to the old design and 3600 ft. of 50-ft. arch spans constructed between the undamaged concrete sheet piling designed to support the original earth fill.

As will be seen in the drawings above referred to, the two rows of piling are about 154 ft. apart. The new structure will be 62 ft. wide, probably supported by piers founded on piles, and a clay fill will be placed between the existing rows of sheet piling, substantially as proposed by William Mueser, of the Concrete Steel Engineering Company, of New York City, who represented Galveston county in the conference. This company designed the undamaged concrete arches in the main part of the causeway. The total cost is estimated at \$1,500,000, and it is reported that the railroad managers will probably act favorably on this recommendation within two weeks.

Would Make Contractor's Profits Increase with Saving to Owner

A method of letting percentage contracts, whereby the contractor can make more money by reducing the cost of a job than by increasing it, is illustrated by a clear example in a recent monthly letter of the Master Builders' Association of Boston. The contract is drawn so that the cost of the work is not to exceed a certain sum, which includes a percentage of profit to the contractor on the actual cost, and if the contractor produces the work at a less cost than the maximum, he is allowed a bonus percentage on the amount saved such that the result will be an increased profit to the contractor. As an illustration, suppose that a maximum cost of \$10,000 is agreed upon, with a 10 per cent profit on the actual cost and a 20 per cent bonus on any saving. If the contractor makes the total cost exactly \$10,000, the actual cost would then be approximately \$9,091, and the 10 per cent profit \$909. If, however, the contractor succeeds in keeping the actual cost down to \$8,000, the accounting at the end of the job will stand thus:

Actual cost of work	\$8,000
10 per cent profit	800
Cost to owner	\$8,800
Saving under maximum cost	1,200
20 per cent of saving paid contractor	240
Total profit to contractor	1,040

It will be observed that this leaves the contractor \$131 better off than if he had made the job cost the maximum allowed. Meanwhile, including the bonus, the owner has paid \$9,040 for the work, which leaves him a saving of \$960 on the guaranteed cost. It is best to make the bonus percentage 20 per cent, as, if it is lower, the increase in the contractor's profit for keeping the cost down will be nominal. For instance, if only 10 per cent had been allowed, the contractor's profit in the above example would have been only \$11 greater if he had done the job for \$8,000 than if he had done it for \$10,000. Extra work ordered or savings on price are added to or deducted from the contract price, giving a new maximum.

Los Angeles County Engineer Reports on Flood Control Needs

A report recently submitted to the Los Angeles Board of Supervisors by J. W. Reagan, engineer for the Los Angeles county flood control district, recommends that protective measures be taken immediately at the Mission bridge and at the mouth of the San Gabriel canyon, and that this work be carried out under the supervision of the highway department.

Mr. Reagan advises that span bridges be erected instead of rebuilding the pile trestles. He points out that "flimsy" structures of the latter type are too frequently built, and that nearly every year some of them collect debris awhile and then go out, causing the destruction of property lower down in the valley, and incalculable inconvenience in highway connections and business loss.

The report states that a map and details

showing the official channel of the San Gabriel River from Mission bridge to the Stewart bridge will be prepared immediately. Owners of property abutting on the Rio Honda, or old San Gabriel River, between the Montebello and the Foster bridges, the report states, have offered to the county free of cost the land necessary for the official channel.

Building Officials Conference Advocates Enclosed Fire Escapes

Two important resolutions, advocating that discretionary power be vested in building officials and that inclosed stairways should be provided for every building were passed at the second annual meeting of the Building Officials Conference held Feb. 14 at the Auditorium Hotel, Chicago. About thirty representatives of building departments and bureaus throughout the country were present. The morning and part of the afternoon sessions were devoted to discussing the recent changes and improvements in building codes and the desirability of giving building officials discretionary power, a large part of that discussion being devoted to the question of the certificate of occupancy. Other topics that occupied some of the time were the use of terra cotta blocks and gypsum products, metal lath and wood shingles. The discussion on these various matters proved so interesting that an evening session had to be arranged for in addition to those scheduled.

The following resolutions were adopted by the conference:

Resolved: That discretionary power should be vested in building officials to vary or modify the law, where practical difficulties arise in its literal enforcement, so that the intent of the law is secured; and that in case the building official declines to exercise such discretionary power an appeal should lie to a board of technical experts.

Resolved: That proper means of egress from every building should be provided in the form of inclosed stairways; that outside metal fire escapes should not be considered as a required means of egress from new buildings, and that their use should be confined to existing buildings where other means of egress are impractical; and that wherever such fire escapes are used the opening thereon should be protected by metal sash and wire glass or by fire-resisting doors with proper fusible links.

Rudolph P. Miller, of New York City, was elected to serve as chairman of the conference for the next year and James G. Houghton, building inspector of Minneapolis, was elected vice-chairman. Sidney J. Williams, state building inspector of Wisconsin, was elected secretary.

California Waterways Association Holds Annual Meeting

On Feb. 21-22 the Inland Waterways Association of California held the regular annual meeting at San Francisco, Cal. The program for the first morning's session included addresses by Isidor Jacobs, president of the association, and Hiram W. Johnson, governor of California. Two papers were presented at this session, "Uses of Streams" by Stephen I. Miller, assistant professor of economics, Stanford University, and "California's Water Problems Outlined" by A. W. Frye.

At the afternoon session of the first day papers were presented on "Governmental Agencies Dealing with Various Phases of our Water Problems" by J. B. Lippincott and D. L. Board, and "The Department Plan in Public Work," by C. E. Grunsky.

On the second day the papers presented were "The Co-ordination of Federal Agencies Proposed by the Newlands-Broussard River Regulation Bill," by George H. Maxwell, and "Co-ordination of Voluntary Organizations," by Capt. Wilson I. Davenny, field secretary National Rivers and Harbors Congress, Washington, D. C.

Iowa Engineers Give Approval to License Law

Collaboration with Architects Sought—Free Engineering by Technical Service Bureau and Manufacturers Discussed

At the twenty-eighth meeting of the Iowa Engineering Society, held in Des Moines, Feb. 16, 17 and 18, approval was given a licensing law for engineers. It was suggested, however, that the engineers and the architects should collaborate in drafting the proposed law.

The society found it unnecessary to take official action in regard to free engineering advice as proposed by the Technical Service Bureau since the matter has not been pressed following several conferences between a committee of the society and the authorities of the Iowa State College.

The committee on professional ethics and standard fees reported in two parts; first, a set of standard fees which the society was not ready to adopt, but, instead, referred back to the committee for further consideration; second, the report on professional ethics. The committee proposed no set of ethics but discussed at considerable length the habit which certain manufacturers have of advertising and furnishing free engineering advice in connection with their selling methods. The society realizes that this arises from a spirit of competition among the manufacturers, but feels that since it does work harm to the engineering profession, that something should be done to minimize the difficulty. The committee was given authority to investigate and to make proposals for its alleviation at the next meeting.

It was the sense of the society that there should be a uniform method of assessing paving costs in all the cities of Iowa. To this end the matter of drawing up a bill to accomplish it was referred to the committee on legislation for their action.

Prof. F. H. Newell of the University of Illinois delivered a short address on "Co-operation" making special reference to the American Association of Engineers.

At the annual banquet Major Cheney, U. S. Corps of Engineers, U. S. A., gave a short talk on "The Engineer in Modern Warfare."

The following officers were elected for the ensuing year: President, S. Hall, consulting engineer, of Centerville; vice-president, C. H. Young; secretary-treasurer, J. H. Dunlap, Iowa City; directors, T. S. Delay and F. S. Alden.

Indianapolis Sewer Construction in 1915 Cost Almost \$1,000,000

In a summary of results of public improvement projects completed in Indianapolis during 1915, the board of public works has announced that the year's work included the construction of sewers at a cost of \$906,794, exclusive of the Pogues Run drain, which will be finished at a cost of \$943,000.

The sewer construction program for 1915 included 77 contracts, and totaled 45 miles in length. The largest of the four principal improvements was the College Avenue Sewer District, just being completed now, with a length of 7.27 miles, extending from Thirty-eighth Street and College Avenue to Fiftieth Street, and embracing surrounding territory. This work will cost \$199,332.48. The second big sewer was on Central Avenue, from Thirty-eighth Street to Fiftieth Street, 5.43 miles in length, and costing \$143,732.10.

A large sewer, extending from Fall Creek to Thirty-eighth Street, to take care of the overflow from the College and Central Avenue sewers, also was constructed. The sewer is 8½ ft. in diameter throughout and cost \$78,210. The fourth was on Warman Avenue, in West Indianapolis, extending from Eagle Creek and Morris Street north to Michigan Street, and thence west to Tibbs Avenue. This covered a distance of approximately 3 miles and cost \$114,504.

Military Map Data Collected Quickly by Approximate Methods

(Continued from page 295, column 2.)

terial of which constructed, together with length, width and height of the water.

The map also should show the character and configuration of the ground, contours indicating all hills and relative elevations, height, shape and character of their slopes; all ravines and undulations which afford protection to a firing line or for the movement of troops. It should locate objects forming obstacles or giving cover, wooded areas, swamps, cultivation, building, fences, hedges and walls. The street plans of towns and villages should be plotted, as well as available camp sites, water supplies, grazing facilities and the like.

Military maps are made according to a uniform system of scales and contour intervals. These schedules are, 1 in. to the mile, vertical interval 60 ft.; 3 in. to the mile, vertical interval 20 ft.; 6 in. to the mile, vertical

by means of a scale across which a plumb-bob line hangs. Hand levels also are of value.

Photography is used to some extent in military map-making and sketching and each engineer company is provided with a camera.

As to the speed of work Captain Coiner said that a good sketcher, on foot, will cover about 10 miles a day, and a mounted map-maker will cover 15 miles a day on road sketching work. Owing to the extent of present-day battle-fronts large map-making forces must be used and their sketches turned in to an engineer officer every night for consolidation and use in planning the orders for the next day. Each engineer company also is fitted with equipment for making blue and brown prints and lithographs. A portable mimeographing outfit also has proved of service.

The main consideration in this branch of the Army service, however, is the getting of results quickly, and the engineer officer often must improvise methods and equipment to secure the data desired.

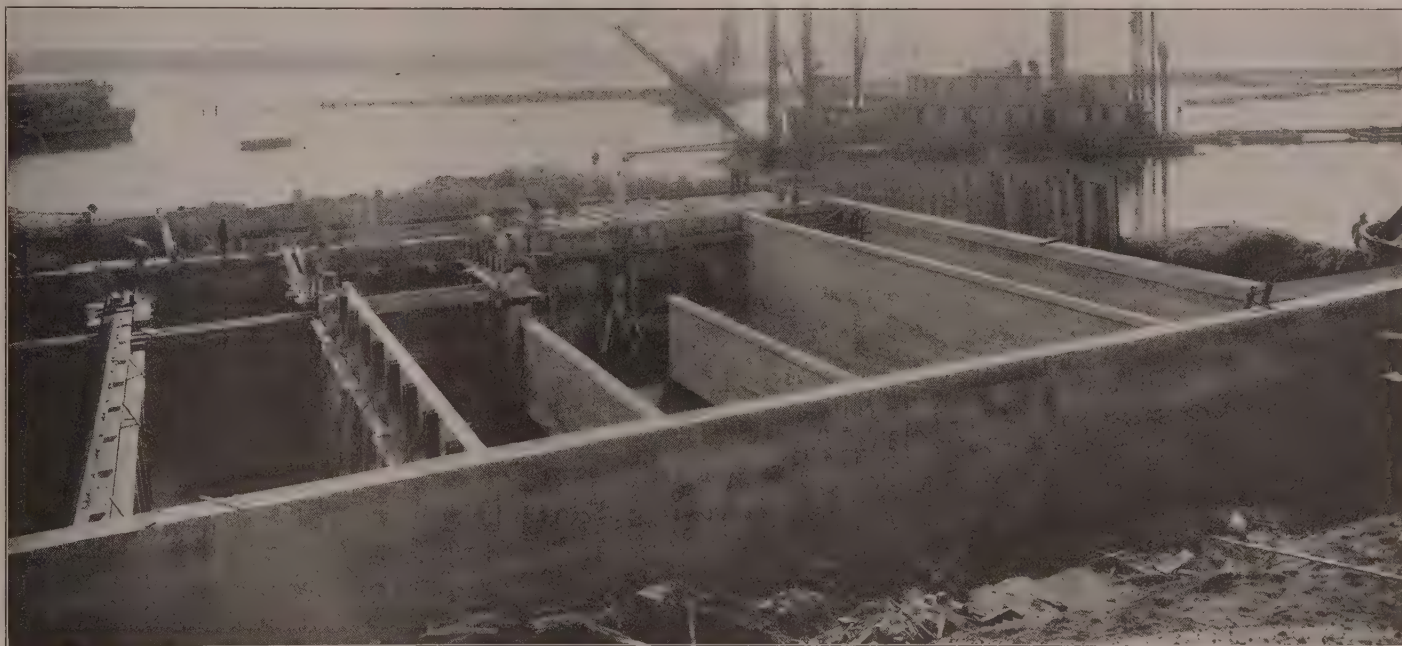
The meeting was attended by about 1000

Constitutional Amendments Proposed to American Society

Several radical changes in the constitution of the American Society of Civil Engineers are proposed by the committee appointed by the board of direction to prepare a draft for a revision to simplify the constitution by making it more general and fundamental. In order to ascertain the feeling of the members, the committee, which consists of M. T. Endicott, J. A. Ockerson, G. F. Swain, Hunter McDonald, J. V. Davies, H. S. Crocker and C. W. Hunt, secretary, submits the following six questions for careful consideration, a brief statement of the reasons for the submission of each being appended:

1. Shall membership in the society be open to women as well as men?

(This is a question on which there is known to be difference of opinion, and on which there has been much controversy. There is nothing specific about it in the present constitution, and



CONSTRUCTION VIEW OF THE NEW SEDIMENTATION BASIN WHICH WILL IMPROVE PHILADELPHIA'S WATER SUPPLY

interval 10 ft.; 10 in. to the mile, vertical interval 5 ft.

Quick Work Necessary

The maps which the Engineer Corps makes are of two general types, road sketches and area sketches. Of the area sketches there are three subdivisions—position sketches, for camp sites, etc.; outpost sketches, made within friendly lines; and place sketches, made from a single point of observation. As speed is so essential in the military sketcher's work, more or less primitive methods are employed in collecting information. Distances ordinarily are measured by pacing, either on foot or horseback. Another method is by counting the revolutions of the wheel of a wagon. In pacing on foot the error generally is less than 3 per cent in 500 yd. In road sketches the distance for side shots is usually estimated in yards, the same unit that is employed in estimating range for rifle fire, so that a man can soon become very skillful in approximating distances and ranges.

The general principles of plane-table surveys are employed extensively in Army practice. The plane table is known as a sketching board and sometimes an alidade is used. Ordinarily, however, rougher methods are employed and shots are located by sighting along a ruler and pacing or estimating the distance to a given point. The vertical angles are obtained by the use of a clinometer or slope board. The matter involves sighting along one edge of the board and measuring the vertical angle

engineers and was presided over by John W. Lieb, Jr., vice-president of the Consolidated Gas Company, New York, and past-president of the American Institute of Electrical Engineers.

Engineers to Bring Civic Societies of Chicago Together

The engineering societies in Chicago have plans under way to give a banquet in the near future to the newly appointed engineers of the Traction and Subway Commission, William Barclay Parsons, Bion J. Arnold and Robert Ridgway. Various civic organizations and societies are being interested by the engineers to make it an occasion at which the public may learn of the confidence of engineers in their fellows as well as to identify engineers with the movement for the development of a greater Chicago.

New York Assembly Passes Bill Appropriating \$10,000,000 for Roads

Despite the protests of the New York City administration, the State Assembly passed the Maier bill, appropriating \$10,000,000 for highway work in upstate counties, Feb. 21. The money will come out of the second \$50,000,000 highway bond issue, which has been apportioned among all the counties of the State except the five counties in New York City.

it is doubtful if the framers of the original constitution ever thought of the possibility of a woman desiring to become a member.)

2. The board of direction now elects members in all grades. Shall it also have power to expel and discipline?

(The present Constitution provides for no disciplinary measures, but does provide for expulsion, which must originate with ten members, and the subsequent procedure is prescribed in great detail, and finally provides that after full investigation the board may expel, but, if the member under trial so elects, must, in order to make such expulsion valid, be upheld by a letter-ballot of the corporate membership. A careful examination of the process which must be followed (see Art. III. Sec. 6,) is convincing that the present constitution is in this respect practically impossible of application.)

3. Shall the duties of a professor of engineering in a technical school be considered as equivalent to responsible charge of engineering work?

(The present constitution states that "The performance of the duties of a professor of engineering in a technical school of a high grade shall be taken as an equivalent to an equal number of years of actual practice." This has always been interpreted to mean that the performance of such duties cannot be construed as "responsible charge" of engineering work, and therefore that no professor may be made a corporate member unless he has had

"responsible charge" in addition to his practice as a teacher.)

4. Is it desirable that the society should adopt some form of district organization along lines advocated by the meeting of the presidents of the local associations at the time of the annual meeting of 1915?

(An amendment to the constitution has been adopted by which the society is in future to be divided into 13 districts instead of 7 as now exist, each of these districts to be represented upon the board of direction. The recommendations of the meeting of the presidents of local associations are briefly, that in each of these districts there shall be a district organization reporting to the parent society whenever necessary, and that every member of the society in any grade residing in that district shall become a member of the district organization without the payment of additional dues. Local associations as now existing or as formed in the future will have their own local government as at the present time.)

5. Shall persons who are engaged in the promotion, manufacture, or sale of proprietary or patented articles used in engineering work (a) be admitted to the society? (b) If so, shall they be placed in a class by themselves?

(The only class in which salesmen may possibly be placed under the present constitution is that of associate, and it is frequently difficult for the board of direction to tell whether a person engaged in commercial engineering is, strictly speaking, eligible for this grade.)

6. Shall the present requirements for admission to the highest grade of corporate membership be increased?

Three Minnesota Engineering Organizations Participate in State Society's Convention

Co-operation with two local and another state organization in holding participatory meetings was the feature of the meeting last week of the Minnesota Surveyors' and Engineers' Society. The furnishing of free engineering services was condemned by a resolution adopted as being misleading to the public and demoralizing to the engineering profession.

The enthusiasm with which Prof. F. H. Newell's address on "Public Duties of an Engineering Society" was received at a joint session of the state organization, Engineers' Club of Minneapolis and the Civil Engineers' Society of St. Paul, indicates the fast-growing interest in this topic.

One whole session was given up to a paper on highway work of the state, in which the following topics were discussed: "Contract Road Work," by R. W. Acton; "Handling Surfacing Materials by Tractor and by Team and Comparison of Cost," by Orrin J. Kipp; "Earth Road Construction by County Outfits," by P. L. Minder; "Work of the Commission," by George W. Wooley, state engineer.

Two railroad papers were presented: "Railroad Construction in Muskeg Swamps," by P. L. Pickles, chief engineer Duluth, Winnipeg & Pacific; "Ore Dock No. 5," by F. C. Baluss, bridge engineer of the same company. W. C. Armstrong, chief engineer Union Depot Company, St. Paul, spoke on "The Relation Between the Architect and the Engineer."

Drainage occupied the attention of the society for three papers, and municipal problems for five papers.

It was stated that several companies had offered free services of their engineering forces to furnish detail plans of reinforced concrete and steel structures, of tile drainage systems and other engineering works. The practice was denominated "Misleading to the public, not conducive to fair and impartial commercial consideration, and demoralizing to the engineering profession in general." The society protested and will use every honorable means to discourage the practice.

Other resolutions passed by the society were as follows: Betterment of drainage laws; in-

creased the dues; the appointment of a committee to urge the State Board of Health to define more adequately the laws controlling water supply and sewage disposal; approval of the St. Croix valley highway improvement, and one advocating the removal of restrictions as to compensation of county surveyors so that the work may be paid for on its merits.

The society was the guest of the Minnesota section of the American Society of Mechanical Engineers at the University of Minnesota to hear a talk on cement by George P. Dieckmann.

George H. Herrold, secretary for several years past, declined the renomination, as he has been chosen president of the Civil Engineers' Society of St. Paul. The following officers of the state society were elected: President, F. W. McKellip, city engineer, Faribault; vice-president, B. J. Reynolds, drainage engineer, Redwood Falls; secretary-treasurer, W. F. Rosenwald, State Highway Commission, St. Paul.

Recommend Flood Control Bond Issue of at Least \$3,600,000

The Los Angeles Flood Control Association, which was recently organized at Los Angeles, Cal., on Feb. 13 passed by practically unanimous vote a recommendation, addressed to the county board of supervisors and carrying the following program for flood control; (1) That the bond issue now being considered for flood control shall not be less than \$3,600,000, and as large as the supervisors decide is necessary for adequate protection. (2) That the bond question shall not be segregated on the ballot as to amounts for different purposes, but placed before the voters as one proposition. (3) That a comprehensive plan of flood control, embracing all the various features of (a) conservation through the construction of a series of check dams in the mountain districts and spreading of streams at the mouths of canyons; (b) reclamation in the lowlands by defining and straightening the channels of streams and rivers, and the reinforcing of banks in dangerous and low place, and (c) the protection of the harbor from silt, should be worked out by the flood control engineer as soon as possible. (4) That the voters shall be given full information as to what the plan is before the election and the proposition as placed before them shall state how much money is to be expended for each kind of control work.

Urge Compulsory Appointment of Engineer on Maryland Commission

As a means of furthering the passage of a bill that would amend the public service law of Maryland to the extent that would specify that one member of the Public Service Commission should be an engineer, the Engineers' Club of Baltimore has sent a letter to members of the State Legislature, which says, in substance:

"It is universally recognized that mathematics, science and engineering subjects are the greatest factors in the education of human intellect and the development of the power of differentiating substance from elusive matter. An engineer is the best prepared person to grasp intricate and complex problems in any line involving public utilities.

"Any commissioner, before he is of much service as such, must be educated along the above lines either by pre-education, or by statements of experts, more or less biased, produced before him and in the latter case only after several years, and much experience, is he on equal footing with the engineer to grasp the large problems of the kind he has to deal with.

"The problems of the Public Service Commission are legal, financial and engineering. The greater part of those thus far presented have been principally engineering questions, i. e., the Gas Rate Case, the Telephone Case, the orders issued to the United Railways &

Electric Co. in re: physical valuation, etc. The cost of transportation, in fact, the cost of anything in the public service line is an engineering problem. The handling or operation of a public service utility is also an engineering problem.

"Therefore, it is advisable that at least one commissioner have the training and education that will enable him to pass on engineering problems without being entirely dependent upon the statements of interested experts.

"This bill, if passed, will not become a law until June, so it does not affect the appointment of the commissioner whose term begins May 1. As the next term does not expire until May 1, 1918, it can be seen that this bill is being presented from a motive of public welfare, and not to further the interests of anyone in particular."

Institute of Consulting Engineers Opposes Power Station on Potomac

At a special meeting held in New York City for the purpose of hearing the report of its special committee on the proposed central power station site on the shores of the Potomac River in the city of Washington, D. C., the council of the American Institute of Consulting Engineers adopted resolutions opposing the erection of the plant on such a site and declaring that it will be a "hideous object in the forefront of the beauties in Washington upon which the nation is spending many millions of dollars." The resolution adopted reads as follows:

Whereas, A site in the city of Washington has been purchased for, and the work actually started upon, a Government light, heat and power station on the waters of the Potomac River, near the foot of Fourteenth Street, in plain view from Potomac and Island Parks, including the new Lincoln Memorial and the proposed new memorial bridge across the Potomac River, and also indirectly visible from other Government grounds and buildings; and

Whereas, The construction of a power station with its towering chimneys, upon this site will be a hideous object in the forefront of the beauties of Washington upon which the nation is spending many millions of dollars;

Now Therefore, Be It Resolved, That the American Institute of Consulting Engineers hereby enters its earnest protest in the interest of the American people against the erection of a power station upon the proposed site on the waters of the Potomac River in the City of Washington, and recommends that work thereon be suspended pending a thorough and disinterested inquiry into the subject by the National Art Commission, aided by competent engineering advice, with a view to a selection of a site that will not be offensive to the artistic sense of the nation and that will conform to economic principles; and

Be It Further Resolved, That copies of these resolutions be sent to the chairmen of the various legislative committees at Washington now considering this subject, and to the press, and also to the members of the Institute, with a request that they bring the facts to the attention of those within their circle, who will endeavor to convince their representatives in Congress that this matter is of national importance and should have the attention recommended herein.

The resolution was signed by the following: William J. Wilgus, chairman; Reginald Pelham Bolton, Colin M. Ingersoll, Charles W. Leavitt, Ralph D. Mershon.

To Hold Drainage Conference at University of Illinois

A conference on drainage and related subjects will be held at the University of Illinois under the auspices of the department of civil engineering, March 8-11. Land reclamation, flood protection, levee construction, and their importance to the agricultural interests of the state will be discussed by engineers and contractors who have specialized in such work. The program includes the names of George Parsons, president of the National Drainage Congress; Edmund T. Perkins and Isham Randolph, consulting engineers; S. H. McCrory, chief of drainage investigations, U. S. Department of Agriculture, and W. L. Park, of the Illinois Central Railroad. The practicability of an annual short course in drainage engineering under the direction of Prof. F. H. Newell, head of the department of civil engineering, and formerly director of the U. S. Reclamation Service, will be considered.

International Engineering Congress Issues Mechanical Engineering Volume

The committee of management of the 1915 International Engineering Congress has announced that the volume on mechanical engineering is ready for distribution and that the members who have subscribed for it will soon receive it. The other volumes will be issued as rapidly as possible. Owing to the large amount of material to be reprinted, and the thousands of copies to be bound, the work cannot be carried on with greater speed. It is hoped that within two months the entire set will be completed.

Members who did not send in their final selections may not be able to secure all the volumes they might have had in mind, and the committee has decided to close the lists for certain volumes which have been sent to the press. It may be possible to supply members who apply with copies of volumes which have not gone to press.

Bethlehem Steel Corporation Buys Pennsylvania Steel Company

For the sum of \$31,900,000, which is at the rate of par for the preferred stock and about \$27 per share for the common stock, the Bethlehem Steel Corporation has purchased the Pennsylvania Steel Company. Formal announcement was made on Feb. 18, following a meeting of the board of directors of the corporation. At this meeting Chas. M. Schwab was elected chairman and E. G. Grace was elected president of the board of directors of the merged companies.

Omaha, Neb., Changes Paving and Curbing Specifications

The City of Omaha, Neb., has changed its specifications for paving and curbing in many details. The city's power to revoke contracts and complete the work itself is enlarged, and the concrete proportions for paving base are changed from 1:3:6 to 1:2½:5. Concrete curbing is to be of monolithic construction instead of base and finish as hitherto. Three grades of artificial stone pavement are established: one reinforced by steel and having protecting plates; one without reinforcement, but having protecting plates, and one without either reinforcement or plates.

Estimates Prepared on New Water System for Albuquerque, N. M.

A new water system for Albuquerque, N. M., could be built for approximately \$413,000, according to a report by James N. Gladding, city engineer of El Paso, who made the estimate at the request of the Albuquerque city council. The estimate includes the following items:

Reservoir	\$41,762
Well system	4,124
Main pumping station	15,114
Sub-pumping station	6,384
Pumping plant	42,650
Meters, hydrants, valves and specials	19,485
Distribution system	133,449
House connections	80,907
Engineering and overhead	68,775
Total	\$412,650

The last item includes besides engineering costs, incidentals, taxes, interest, office expenses, legal advice, equipment, liability insurance and contractors' profit. A sub-contractor's profit is also included in construction and materials estimates.

A well system of water supply is the best that could be obtained, the report states, owing to the geological formation in the vicinity of the city, which consists of a layer of coarse sand and gravel saturated with water and

extending from depths of 4 or 5 ft. to about 45 or 50 ft. below the surface. This furnishes an almost inexhaustible supply and the gravel forms a large natural filter. Wells sunk into, but not through, this gravel give large flows and 8-in. wells have yielded, it is reported, as much as 1000 gal. per minute. It is recommended that three pumping stations be installed, each with enough wells to produce 1,000,000 gal. every 24 hr. Two concrete-lined reservoirs, each having a capacity of 3,500,000 gal., to furnish ample storage, are also recommended. The proposition is to be voted on at the next municipal election.

Spokane to Consider Bond Issue for New Bridges

Four bridges within the city of Spokane will probably be replaced by heavy steel or concrete structures, if the action which is now contemplated is approved. The cost of the new structures would be about \$500,000, and repairs on other bridges would cost about \$200,000, according to press reports. The question is now the subject of an investigation by the city's engineering staff, and it is expected that the report to the city council will be presented in the near future.

To Establish Large Research Laboratory

Following a personal study of industrial conditions in Germany and other foreign countries by Dean Frederick A. Goetze and several members of the faculty of the graduate engineering school of Columbia University, he elaborates in his annual report, which has just been issued, the proposed plans for the foundation of a large industrial engineering research laboratory under the auspices of the university. Such a move, he sets forth, would be a boon to the industries of this country, bringing to their aid, as is done in Germany, keen university research study to solve the many engineering problems which confront them.

The plan outlined by Dean Goetze and his colleagues calls for the immediate erection of a building easily accessible to the university, with water and railroad facilities, which with the equipment necessary would cost \$500,000. This would be an initial step, however, as it is ultimately proposed that a research foundation of from \$2,000,000 to \$5,000,000 be secured, the income to be used exclusively for engineering research.

Form Catskill Aqueduct Association

To keep alive friendships started on the Catskill Aqueduct work, a permanent organization known as the Catskill Aqueduct Association has been formed, with the object of bringing together each year all those who have been or are connected in any way with that work.

A committee consisting of the following men has been designated to arrange for the 1916 reunion: H. C. Buncke, J. F. Sanborn, W. E. Spear, S. F. Thomson, Beverly R. Value and W. J. Buhrendorf, secretary. The committee has made arrangements for a dance at the Biltmore Hotel, New York City, March 7. Tickets may be obtained from the secretary, or any member of the committee. The office of the secretary is in Room 2224, Municipal Building, New York City.

News of Engineering Societies

The Engineers Club of Philadelphia will hold a special meeting March 4 to hear a paper on "Hydrated Lime in Concrete Mortars," by Prof. James S. Macgregor of Columbia University.

The Civil Engineers Society of St. Paul heard E. J. Mehren, editor of the Engineering Record on "The Proposed Removal of the Headquarters of the American Society of Civil Engineers" at a meeting held in that city, Feb. 21.

The American Society of Civil Engineers will hold a meeting in New York City, March 1. Joseph W. Ellms and John S. Gettrust will present a paper on "A Study of the Behavior of Rapid Sand Filters Subjected to the High-Velocity Method of Washing," and Henry S. Prichard will present one on "The Effects of Straining Structural Steel and Wrought Iron."

The American Chemical Society will meet in Urbana, Ill., April 18 to 21. An exhibition of chemical industries is to be held in conjunction with the meeting and the dedication of the new chemistry building of the University of Illinois. No charge is to be made to exhibitors and necessary gas, water, electricity and drayage will be furnished free. Correspondence should be addressed to the chairman of the exhibits committee, H. L. Olin, Urbana.

The Oregon Society of Engineers held its fifth annual banquet in Portland on Feb. 7. Newly elected officers were announced as follows: Philip H. Dater, vice-president; Orrin E. Stanley, secretary, and Henry M. Morse, treasurer. The first issue of the "Journal" which will hereafter be issued by the society, appeared at the meeting. It is intended to publish in the "Journal" not only the papers read before the society but others which may be contributed for this purpose by members.

The San Francisco Association of Members of the American Society of Civil Engineers held the regular bimonthly meeting on Feb. 18. After an address by H. L. Haehl, the new president of the organization, the secretary read a communication from J. A. Ockerson presenting an argument against the proposed move of society headquarters into the Engineering Societies' Building in New York. Discussion developed the fact that many of those present disagreed with Mr. Ockerson, and it was decided to write to Secretary Hunt for additional information on certain points involved; the question to be considered again at the April meeting. A. B. Foote, superintendent of the North Star Mining Company, Marysville, Cal., presented an illustrated paper on the pumping, ore hoisting and conveying equipment installed at the company's properties.

Personal Notes

H. L. FISHEL, division engineer for the Santa Fé, Prescott & Phoenix Railway, has been promoted to the position of pilot to federal engineers engaged in the appraisal of structures for the Atchison, Topeka & Santa Fé system, and will have his headquarters at Topeka, Kan.

GLEN P. BEACH has resigned his position as assistant engineer to the Minnesota State Railroad and Warehouse Commission, to take effect April 1.

G. M. DERR has resigned his position with the Riter Conley Manufacturing Company of Pittsburgh to become connected with the engineering department of the Trussed Concrete Steel Company of Youngstown, Ohio.

T. J. DEAN, formerly of Flint, Mich., has become connected with the county surveyor's office at Hillsdale, Mich., on drainage work.

MORRIS W. LOVING, formerly with the Baltimore Sewerage Commission, has been appointed assistant engineer in the extension division of the Universal Portland Cement Company, 208 South La Salle Street, Chicago.

GEORGE O. PLAMONDON, formerly with the Trussed Concrete Steel Company of Youngstown, Ohio, has accepted a position as engineer in the Valuation Division of Interstate Commerce Commission, with headquarters at Chattanooga, Tenn.

CAPT. THOMAS M. ROBINS' subject for the next military lecture at the Engineering Societies' Building, New York, Feb. 28, will be field fortifications, sieges and demolitions.

P. C. CLEMENS has been appointed fourth assistant city engineer of Indianapolis by the Board of Public Works of that city, acting on the recommendation of City Engineer Jeup.

CHARLES A. BROWN has resigned from the position of assistant city engineer of Indianapolis.

HOWARD HOWIE, formerly in charge of the development of new iron mines for the Roane Iron Company of Chamberlain, Tenn., has become connected with the Oriskany Ore & Iron Corporation of Lynchburg, Va.

C. PETERSEN, formerly in the main office of the Trussed Concrete Steel Company, has been appointed sales engineer in the company's branch office in the Munsey Building, Baltimore.

D. W. COLE, of the U. S. Reclamation Service, has been designated senior engineer and resident manager of the Boise Project, succeeding F. E. Weymouth, whose appointment as chief of construction for the Service was noted in these columns Feb. 12. As senior engineer for the Western district, with headquarters at Boise, Idaho, he will have general oversight of all projects in the States of Washington, Oregon, Idaho, Nevada and Northern California for the purpose of advising the chief of construction upon all Reclamation affairs in that territory. Mr. Cole has been in the Reclamation Service nearly 12 years, first upon the construction of the Shoshone Dam in Wyoming, and, latterly, in charge of the Truckee-Carson Project and the construction of Lahontan Dam in Nevada. Previous to the national irrigation era Mr. Cole's engineering practice comprised a number of years in railroad surveys, construction and maintenance, following which he was engaged for 10 years in municipal water works for the City of Waterbury, Conn., the Metropolitan Water Board of Massachusetts, the Commission on Additional Water Supply for New York City and in various hydraulic investigations for the States of Connecticut and New Jersey.

A. E. MILLER and H. W. WENDELKEN have formed a partnership under the firm name of A. E. Miller Construction Company, Turley Building, Portsmouth, Ohio, to engage in a general engineering and contracting business. Mr. Miller has been engaged in contracting work in that vicinity for the past year. Previous to that he was for 3 years erecting engineer for the New York Continental Jewel Company. Mr. Wendelken has had a wide experience in municipal, railroad and highway work, and has been for the past few years, connected with the Ohio State Highway Department.

J. P. WELLS, consulting engineer, of Rochester, N. Y., specializing particularly in hydraulic and sanitary practice, has moved his offices from the Exchange Place Building to the Cutler Building.

P. D. FITZPATRICK has been appointed valuation engineer of the Central Vermont Railway, with headquarters at St. Albans, Vt.

T. D. SEDWICK, formerly chief chemist of the Chicago, Rock Island and Pacific Railway, has been appointed acting engineer of tests, succeeding F. O. Bunnell, resigned.

HENRY E. ELROD, consulting engineer, of Dallas, Tex., has been retained to design a waterworks and sewer system for the City of Cooper, Tex.

GEORGE J. EYRECK, JR., has been appointed engineer for F. W. Long & Company, general contractors, 434 East Bay Street, Jacksonville, Fla.

D. W. TOWNSEND, formerly connected with the Lehigh Valley Railroad, has been appointed to a position on the engineering forces of the Department of Public Works of the Territory of Hawaii, at Wailuku, Maui, T. H. Mr. Townsend is a graduate of Cornell University.

J. W. BARTHOLOW, of the Bartholow-Willits Engineering Company, civil engineers, of Galveston, Tex., has accepted a temporary appointment as assistant to the valuation engineer of the Eastern lines of the Atchison, Topeka & Santa Fé Railway at Topeka, Kan. At the conclusion of his work, which is of a special nature, he will return to Galveston and resume his work with the Bartholow-Willits Company.

W. T. PRICE has been appointed superintendent of the waterworks system of Hood River, Ore., succeeding P. M. Morse, resigned. Mr. Price was formerly engaged in business as a builder and general contractor at Scranton, Pa.

S. Q. CANNON was reappointed city engineer of Salt Lake City, Feb. 10.

HARRY H. BLEE, of Santa Ana, Cal., who has been connected with the state engineering department of California, has been appointed assistant state engineer. The law provides for two assistant state engineers. Mr. Blee is the second to be named, Major P. N. Norboe having been appointed to a similar position some time ago.

STEPHEN W. JONES, HENRY E. CASS and ROBERT L. COBB have formed the Finance & Construction Company, engineers and contractors, Phoenix Building, Minneapolis, Minn., to conduct a financing and general contracting business within the United States. Mr. Jones has had interests in the contracting business for the past thirty years, and Mr. Cobb has been engaged in the writing of contractors' bonds and liability insurance. Mr. Cass is at present vice-president of the Werdenhoff-Cass Company, railroad contractors.

NATHAN C. JOHNSON, consulting engineer, of New York City, delivered a lecture on "Concrete" at the college of engineering of the University of Minnesota, Feb. 19.

E. J. MEHREN, editor of the Engineering Record, delivered an address on "The Relation of College Life to Professional Success" at the college of engineering of the University of Minnesota, Feb. 21.

DAYTON CORSON, JR., has resigned from the office of borough engineer of Woodbury, N. J.

OWEN CARTER has been appointed borough engineer of Woodbury, N. J., succeeding Dayton Corson, whose resignation is noted elsewhere in these columns.

H. M. BRINCKERHOFF, a member of the engineering firm of Barclay Parsons & Klapp, New York City, has been appointed chief engineer of the Chicago Traction and Subway Commission, with offices in the Home Insurance Building. He will direct the investigations of traffic conditions and other factors to determine a plan for consolidated operation of the elevated, surface and future subway systems. After Mr. Brinckerhoff was graduated from Stevens Institute of Technology in 1890 he was engaged in the original electrification of the horse-car lines of Boston. In 1892, in Chicago, as assistant engineer of the Intramural Railway, he devised and installed for the first time the third-rail system. In 1898 he became general manager of the West Side Elevated, a position he held until 1906, when he joined the firm of Barclay Parsons & Klapp. His most recent work in this connection was the supervision and direction of the preparation of a report on the traffic conditions in Detroit for the street railway commission of that city.

JAMES B. ROBINSON, consulting engineer, who was connected with the Southern Pacific Company for many years and later with the Northern Pacific Company, died at Portland, Ore., Feb. 12. Mr. Robinson built the Butte County Railroad between Chico, Cal., and Stirling City, and also the present street railway in Chico.

THOMAS F. MCCRICKETT, engineer for the Russell Wheel & Foundry Company of Detroit, Mich., died in that city Jan. 26, at the age of 47. He was graduated from the University of Michigan in 1897 and was with the Russell Wheel & Foundry Company from that year until his death.

JOSEPH S. WARD, resident engineer of the Philadelphia & Reading Railway at Williamsport, Pa., died Feb. 16. He was born in Philadelphia, and, after graduating from the Polytechnic College of Pennsylvania, started in active work as a draftsman in the Pennsylvania Railroad shops at Meadows, N. J. Later he served as draftsman, transitman, levelman and topographer on the Maderia-Mamori Railroad in Brazil. From 1879 to 1881 he was in the assistant engineer's office of the Pennsylvania Railroad's New York division at Jersey City. From 1881 to 1884 he was with the Mexican National Construction Company in Texas and Mexico. In 1884 he entered the service of the Philadelphia & Reading as assistant in the Philadelphia and New York division.

CHARLES MILLS, a civil engineer in the Department of City Transit of Philadelphia, died in that city, Feb. 15.

WILLIAM J. NICHOLLS, consulting engineer, of Philadelphia, and a former chief engineer of the Long Island Railroad, died in Philadelphia, Feb. 14. He was 62 years old. Mr. Nicholls, during his professional career, served as chief engineer of the Long Island Railroad, as assistant engineer of the Reading and as chief engineer of the Pennsylvania Steel Company. He also did considerable mining work, and was the author of various works on mining and railroad subjects, as well as several books of fiction. He became a member of the American Society of Civil Engineers in 1878.

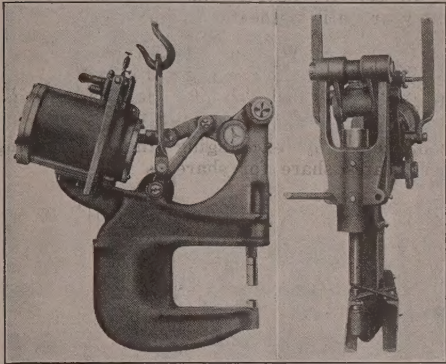
STEVENSON TOWLE, for many years chief engineer of New York city sewers, and builder of the first cable railway in that city, whose death was noted in these columns last week, was born in New York City in 1837. He received his professional education at the Free Academy—now the College of the City of New York—and was appointed city surveyor of the city in 1857. In 1860 the mayor designated him to examine the sewer systems of European cities, for the purpose of obtaining the information on which the present sewer laws of the city are based. He was chief engineer of New York sewers from 1870 to 1886. In 1871 he served with Generals McClellan and Franklin on a commission appointed to lay out Long Island City, and, in 1883, he planned and built the first cable road in New York City—the Tenth Avenue line. In 1886 he became consulting engineer of the Broadway Arcade Rapid Transit Railroad, and in the following year was appointed by Mayor Hewitt a member of the Rapid Transit Commission. In the same year the Mayor selected him to visit Europe and personally investigate the question of improved pavement throughout the cities on that continent. He was appointed a park commissioner in 1888, and, in 1889, he became consulting engineer for the department of public works, in special charge of improved street pavements. He held that position until 1897, when he was appointed consulting engineer of sewerage, in connection with the city rapid transit tunnel. He was one of the original members of the American Society of Civil Engineers, being elected in 1868, and served as director from 1887 to 1888. He was married in New York City in 1863 to Mary Stewart Brevoort, and is survived by three sons and five daughters.

Obituary Notes

W. I. BAUMEISTER, a well-known building contractor of the Northwest, died Feb. 13 in Bellingham, Wash.

Pneumatic Riveter Can Work on Small Latticed Columns

The accompanying photographs illustrate a specially designed Hanna type of pneumatic riveter for lattice column work. A good idea of the limited space in which this machine will operate may be gained from the photographs. The frame, main lever, guide links, toggles, plunger and piston rod head are of cast steel, the main frame bushing and cylinder parts of cast iron and the lower toggle,

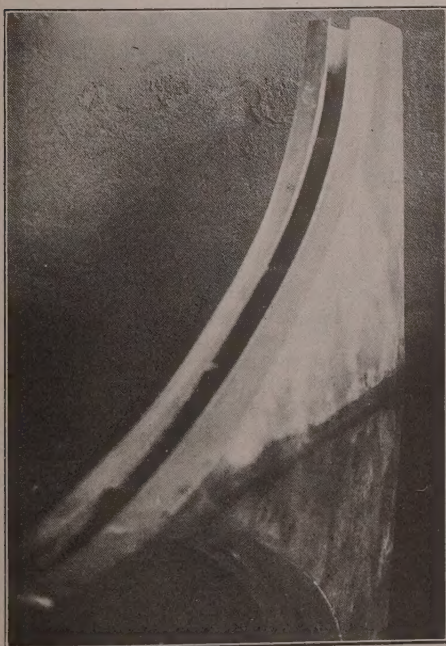


PNEUMATIC MACHINE RIVETS LATTICED COLUMNS

die screw, lower die holder, dies and piston rod of a specially selected high-carbon steel. The usual Hanna mechanism, described on page 775 of the Engineering Record for Dec. 18, 1915, is applied, in which there is combined, in a simple form, toggles, levers and guide links to give the large opening of the toggle joint movement with its gradually increasing pressure, until the desired pressure is reached, then a simple lever movement throughout a considerable space under approximately maximum pressure. The machines are made by the Hanna Engineering Works, for which the Vulcan Engineering Sales Company is general agent.

Bent Weir Measures Water Proportional to Head

By casting a sloping weir slot on the curve of a right cycloid as shown in the accompanying photograph, the new cycloid weir meter measures quantity of water discharged directly proportional to the head. The weir has recently been placed on the market by the Kennicott Company, Chicago Heights, Ill., which has



DISCHARGE IS PROPORTIONAL TO HEAD

secured basic patents on the device. The company has been experimenting with the device for more than a year in connection with the numerous calls it has in its water softening and purification installations for a weir meter in which the registering device would not be complicated by the necessity of compensating for the values which are introduced in registering the measurement.

One of the weirs has been installed in a water softening plant for the Minneapolis General Electric Company having a capacity of 1200 gal. per minute.

Deep Holes Loaded with Safety

The contractor is following the lead of the quarry man in adopting "well-drilled" holes in deep rock cuts because of the economy of deep blasting. These holes are usually loaded by dropping the charge down them from the top. This is a proceeding attended with some danger, which the Chambers loader, illustrated herewith, is designed to obviate. The loader grips the charge until the trip line is pulled. The load can thus be lowered carefully to the bottom of the hole in sections if the charge be heavy, and the loader can be easily released and withdrawn. All metal parts are protected by a heavy coating, which is said to make the production of sparks, from striking the rock sides of the hole very unlikely. The device is manufactured by George T. Chambers, Le Grange, Ill.

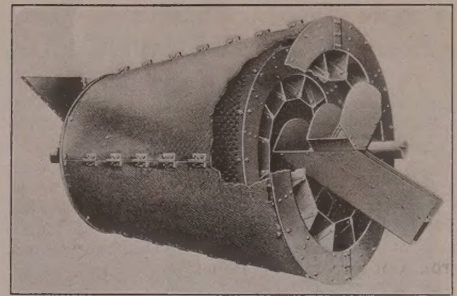


Air Compressors Use Fuel Oil

To obtain an air compressor that would operate cheaply and have a low first cost, the Chicago Pneumatic Tool Company has begun building oil-engine compressors that run on heavy mineral oils costing 3 cents a gallon. These compressors, known as type N-SO, are of the straight line, single stage type with the air cylinder mounted on the main frame between and in tandem with the flywheels and oil cylinder. The two-cycle engine operates at low pressure, using a patented hot-plate system to produce ignition. Air only is compressed, combustion taking place at the end of the compression stroke when an oil pump injects a mixture of oil and water into the cylinder against the hot plate. This mixture is controlled by a fly-ball governor. By using this system it is said that greater fuel economy and practically perfect combustion are attained. The smaller sizes of these compressors are portable. The very low cost at which they compress air, the fuel cost for each 100 cu. ft. per min. warranted by the manufacturer being 56 cents per 9-hr. day, is expected to bring about great extension of the use of compressed air, especially in the way of new uses for this source of power on construction work.

Double-Screen, Self-Contained Unit Washes and Screens Gravel

A new self-contained portable or stationary sand and gravel screening outfit has a washer feature with it in which the clean water strikes the cleanest material. The material is charged through a hopper, shown at the back of the picture, and is dropped directly onto the inner coarse screen. As the screens revolve the finest material goes through the outer screen to a sand hopper, not shown, below the screen. The



TWO SIZES OF GRAVEL ARE HANDLED

gravel travels to the outlet between the two screens, and that on the inner coarse screen is finally picked up by pockets at the bottom of the screen, and pumped at the top into the respective chutes which carry the different sizes to separate storage bins.

The washer is set in a box in which the water submerges it about one-third of its depth. Fresh water is applied through two nozzles, not shown, placed midway of the center line on the drum, each nozzle directing a stream against a single set of buckets.

The screen shown is for a plant having a daily capacity of 300 cu. yd. The large and small ends are 66 and 48 in. in diameter respectively, and the length is 6 ft. A 500-cu. yd. outfit is also made by the Raymond W. Dull Company, Chicago, designer and builder of the outfit.

Repair Steam Hammer on Job with Oxy-Acetylene Apparatus

By use of oxy-acetylene apparatus, a steam hammer that was broken on the Hanover Street Bridge construction in Baltimore was repaired on the job in two days time, thus effecting a considerable saving in loss of time.

In the course of the work the pile driver, driving piles for the pier cofferdams was disabled through the breaking off of a heavy corner from the bottom of the hammer, where it fits around the driving cap. The crippled hammer was laid up on one of the partly finished piers and a Milburn Portable Oxy-Acetylene plant was taken out to the work on a boat. The broken portions were chipped away to allow for the new filling material and the end of the hammer welded back in place. The entire work was completed within two days, saving a considerable loss of time on the job.



BROKEN STEAM HAMMER REPAIRED ON JOB

Simple Device Facilitates Waste Removal in Grand Rapids, Mich.

To solve the rubbish removal problem in the schools of Grand Rapids, Mich., William Walsh, highway commissioner of that city, devised a scheme of wells located in the rear of each building and a handling device by which



CRANE LIFTS AND DUMPS CANS

the deposited rubbish can be readily lifted and loaded onto dump wagons.

The wagons carry galvanized iron cans, which are lowered into the wells, into which the rubbish has been swept, by means of a crank, controlling a wire rope which moves through pulleys attached to a crane. But one man is required to load the refuse, which is drawn up and dumped into the cart. The dumping is done by a rope, terminating in a catch, which is hooked on the base of the can, as shown in the illustration. But little time is required to clean the wells, and one wagon takes care of the needs of all the schools.

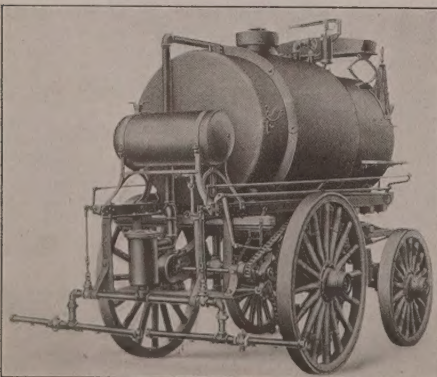
Pressure for Road Oiler with Heater Comes from Rear Wheel

A new pressure road oiler with a heater of 600-gal. capacity has recently been put on the market in which the power pumps are driven by a chain from the rear wheel. It will handle any amount up to $\frac{1}{2}$ gal. per square yard on an 8-ft. strip.

The oil heater as shown in the photograph is in the form of a jacket surrounding the tank and is operated by a kerosene oil improved burner giving a combustion in which the smoke and soot are eliminated.

All levers can be operated from the driver's seat, so that the outfit can be operated by one man.

The machine, which is built by the Austin-Western Road Machinery Company, will handle, it is claimed, oils containing 40 per cent asphalt unheated and oil up to 90 per cent asphalt and all Tarvia products heated.



PRESSURE OIL DISTRIBUTOR HAS HEATER

Declare Timber Supply Abundant

That the timber supply of the nation is sufficient for years to come, and that all that is needed is proper co-ordination in its manufacture, scientific distribution of the manufactured product and co-operation among the various groups of manufacturers and between manufacturers and retailers was the declaration of E. A. Sterling, forest engineer and head of the trade extension department of the National Lumber Manufacturers' Association, before the annual meeting of the Southern Pine Association in New Orleans, February 23.

"That ample lumber resources still remain is indicated," he said, "by the more recent Government estimates, and by careful study of the situation by those most familiar with conditions. Undue publicity has been given in statements that our forest resources are practically exhausted. In fact the enormous reserve supply on the Pacific Coast, now readily available, with large timbered areas still standing in the North, South and East, and with an estimated total of 200,000,000 acres of farm woodlands which still contribute to local needs, the fallacy of a timber famine becomes evident. With this comes the practical certainty that if a reasonable consumption of lumber can be maintained, the gradual adoption of forest management, the reduction of loss by fire, and the longer service to be obtained from lumber by proper selection and preservative treatment, will give us adequate supply for all time."

Business Notes

J. R. Nichols, formerly assistant sales manager at the Pittsburgh office for the Asbestos Protected Metal Company, is opening an office for that company in the Hart Building, Atlanta, Ga.

The Coffin Valve Company, manufacturer of sluice and gate valves, of Boston, has entered into an agreement with C. W. Bergen, 30 Church Street, New York City, to become its New York representative.

J. A. & W. Bird & Company, distributor for North America of Repolin Enamel Paint, of 88 Pearl Street, Boston, has moved its New York City offices from 66 Beaver Street to the Equitable Building, 120 Broadway.

W. B. Knickerbocker, president Knickerbocker Company of Jackson, Mich., manufacturing cyclone heads and concrete mixers, died suddenly Feb. 10, presumably as the result of two serious falls sustained during the past year.

Peter James Cunneen, manager of the Lasing Plant, American Bridge Company, at Chicago, died Feb. 13. Mr. Cunneen was born in 1859 and entered the employ of the old American Bridge Company in 1878. He remained in the employ of that company and its various successors until the formation of the present American Bridge Company.

A. C. Cameron of the Municipal Engineering & Contracting Company, Chicago, was chosen president of the National Association of Mixer Manufacturers at the meeting in Chicago, Feb. 15. The other officials elected were F. C. Wilcox, of the Foot Concrete Machinery Company, treasurer, and H. E. Smith, of the T. L. Smith Company, secretary. Active work toward establishment of the "wet mixed" batch as the basis for rating mixers will be pushed.

The Scherzer Rolling Lift Bridge Company has announced, that, following the death of Albert H. Scherzer, president, the entire stock of the company has been purchased by a syndicate of officials of the company, who have been connected with the business from its inception, and that there will be no change in the personnel of the organization, Mr. Scherzer having taken no active part in the affairs of the company for several years. The company has general offices in the Monadnock Block, Chicago, and an Eastern office at 220 Broadway, New York, with sales connections in various cities of this country and Europe.

The American Coal Products Company and the Barrett Manufacturing Company have decided to unite the good-will and reputation of both concerns under the name of The Barrett Company. The American Coal Products Company is known in connection with the sale of sulphate of ammonia, and heretofore owned the stock of The Barrett Manufacturing Company. The fact that all the coal tar chemicals, disinfectants, roofing, waterproofing, road-making and wood preserving materials have been made and widely advertised in the name of the Barrett Manufacturing Company has added to the good-will attached to it. This increase, however, has not been connected in the minds of the general public with the securities of the American Coal Products Company. The new company will have the same amount of stock as the American Coal Products Company, and the change in the name will be accomplished by exchanging the outstanding certificates share for share.

Trade Publications

The following companies have recently issued trade literature:

Foster & Creighton Company, Nashville, Tenn., booklet, 8 pages, comparative tests, Rockwood, Alabama, limestone.

Sterling Motor Truck Company, Milwaukee, Wis., leaflet, 8 pages, Sterling-Kindling motor "squeegee" street washer.

Studebaker, South Bend, Ind., leaflet 1023, 8 pages, oil heater and pressure distributor for road construction and maintenance.

Whiting Foundry Equipment Company, Harvey, Ill., catalog 119, 20 pages, air hoists of from 350 to 40,000 lb. lifting capacity.

Evinrude Motor Company, Milwaukee, catalog 32 pages, small detachable motor for boats and canoes—a suggestion for surveying trips.

Hayward Company, 50 Church Street, New York City, pamphlet 608, 24 pages, Hayward clamshell and orange-peel buckets put to a variety of uses.

Vanadium-Alloys Steel Company, Pittsburgh, booklet, an article on Tungsten mining in Colorado written by Roy C. McKenna, president of the company.

Stephens Adamson Manufacturing Company, Aurora, Ill., booklet 76, February, 1916, 24 pages, The Labor Saver, semi-portable screening and crushing plants for road work.

Texas Company, New York, booklet, 10 pages, February, 1916. Lubrication, oil behavior in Diesel-type engine, temperature considerations in oil-testing and sundry items about Texaco erater compound.

Chain Belt Company, Milwaukee, supplement to general catalog 56, 32 pages, revised price lists on Standard detachable chain belt and various changes in Chabelco steel chain belt, as well as listing of the new H-type riveted chain belt.

Austin-Western Road Machinery Company, Chicago, catalog, 80 pages, road machines, scrapers, graders, rippers, and planers and finishers. Rock-crushing machinery, portable storage bins, screens and conveyors. Road rollers and road-maintenance machinery.

Allis-Chalmers Manufacturing Company, Milwaukee. Bulletin 1439-A, 36 pages, entitled "Timber Preserving Machinery." Describes briefly various treatment processes, and gives useful condensed information about them, in addition to data regarding the company's make of machinery.

Link Belt Company, Chicago. Eighty-page booklet profusely illustrated with installations of elevators, conveyors and machinery for handling, preparing and storing gravel, stone, sand and other materials. Many dimension tables and layout drawing make the volume particularly valuable. A new scheme of using wagon loaders to handle road materials to wheelbarrows and a new type of high-speed grab-bucket for hard digging are illustrated.